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FLOOD INUNDATiON MCDELLING USING MILHY

Third Interim Report

by

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CONTENTS

I OBJECTIVES

The overall objective of this research project is to improve the accuracy of hydrograph prediction and to incorporate the capability of forecasting inundated areas in the MILHY2 model, whilst maintaining parsimonious data requirements. This is to be achieved by:

(1) Consideration of the impact of spatially distributed precipitation on the runoff hydrograph.

(2) Incorporation of appropriate hydraulic techniques which aim to improve the physical representation of out-of-bank conditions, including:

i) turbulent exchange of flow between cross-sectional segments.

ii) introduction of multiple routing reach paths to allow discrete pathways for deep floodplain flows.

iii) a comparative study of the performance of alternative flood routing techniques in the overbank environment.

(3) Development of a module based scheme where the operator may select either more detailed or simpler module algorithms based on operational rules guiding data requirement, computational demands and solution specifications.

(4) Validation of the methodology by:

i) study of the performance of individual modules using hydrographs and inundation maps from the Fulda database, on scales from 150km^2 to 2500km^2.

sq. km

ii) comparison of the performance of the hydrologically based MILHY3 with the two-dimensional hydrodynamic finite element model RMA-2.

Figure 1.1 illustrates the initial model, MILHY2 at the commencement of this project, whilst Fig 1.2 incorporates the objectives for MILHY3 listed above. Fig 1.3 demonstrates the module components the operator may select.

Fig 1.1

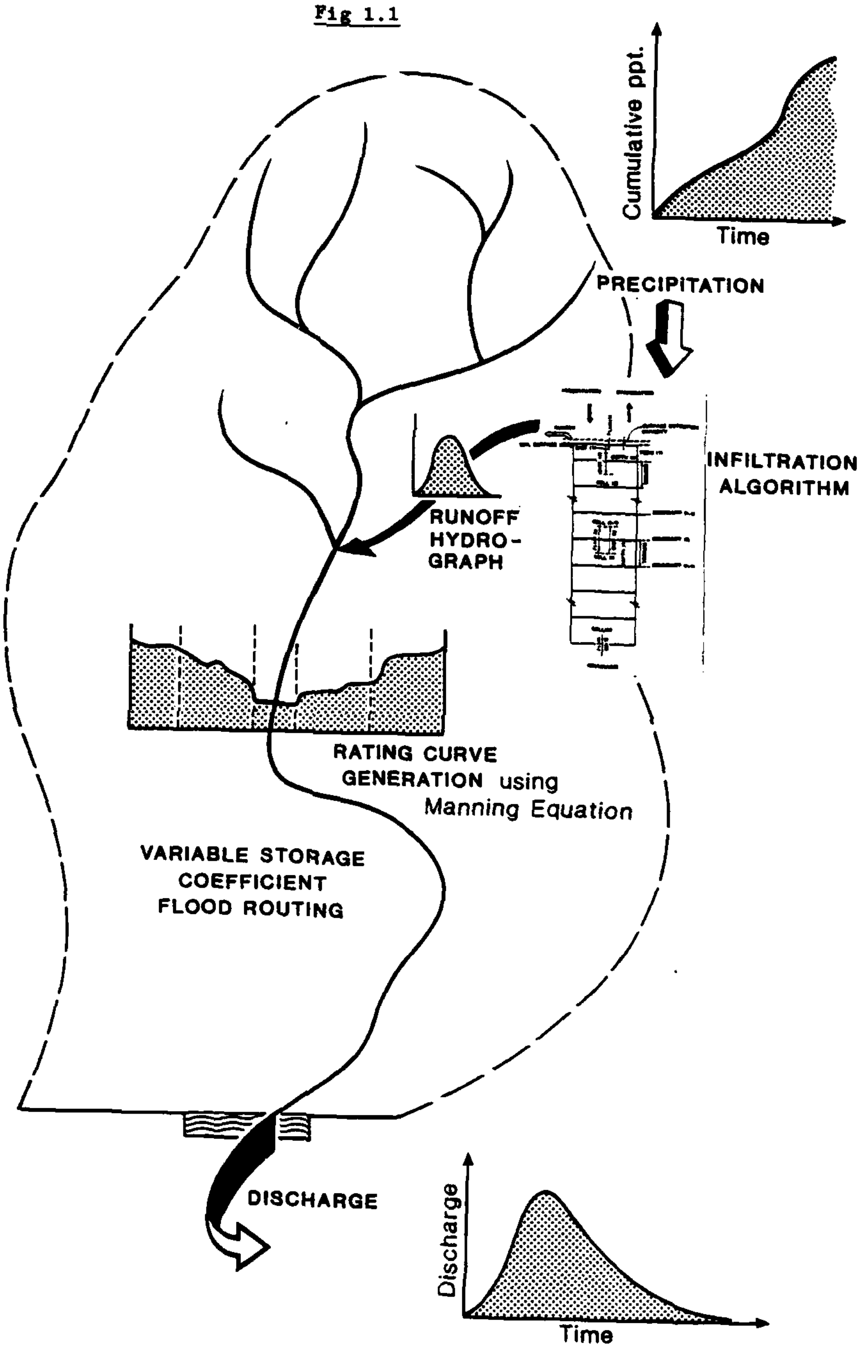

Cumulative ppt.
Time
PRECIPITATION
INFILTRATION ALGORITHM
RUNOFF HYDRO-GRAPH
RATING CURVE GENERATION using Manning Equation
VARIABLE STORAGE COEFFICIENT FLOOD ROUTING
DISCHARGE
Discharge
Time

Fig 1.2

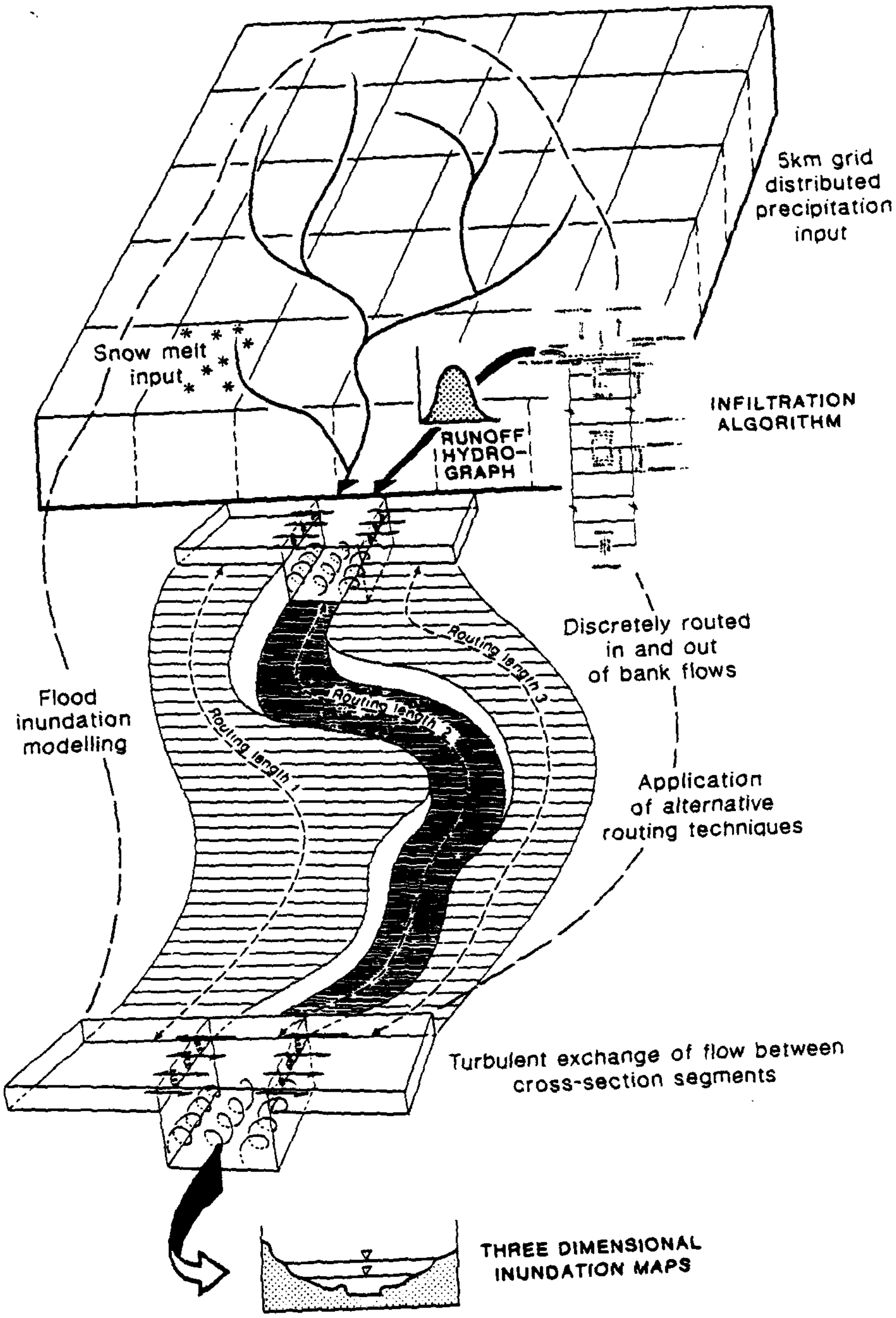
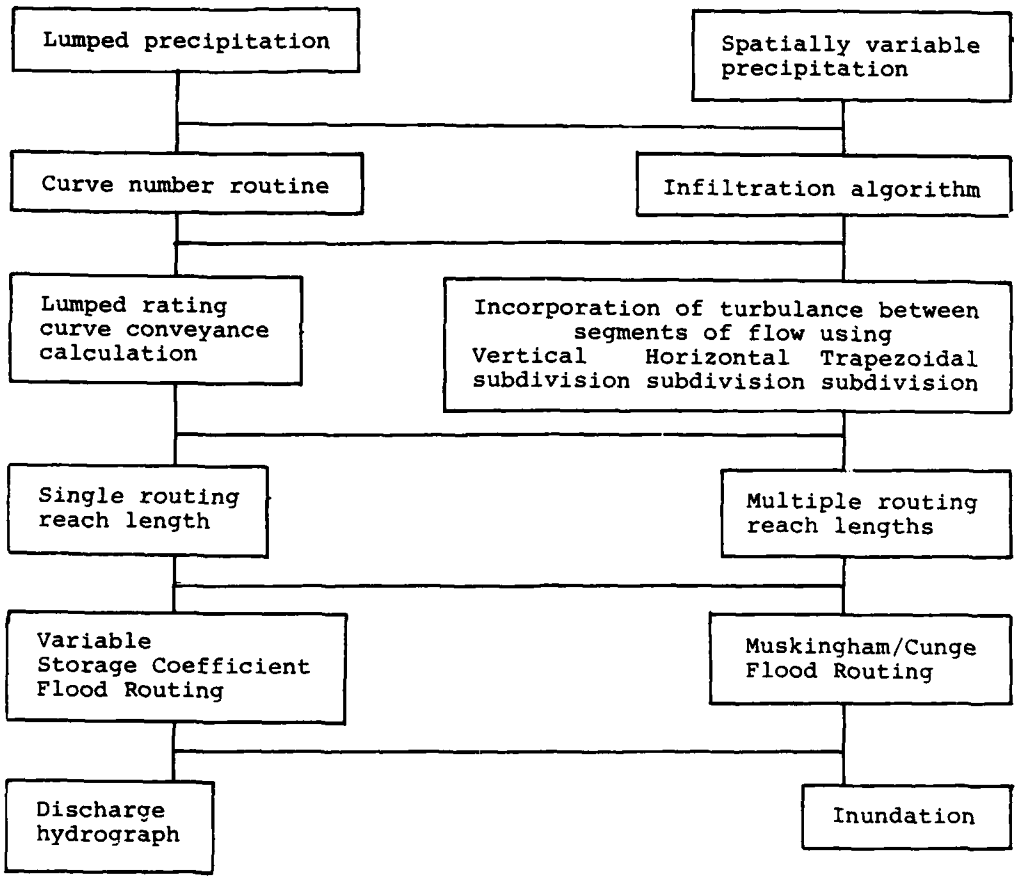

5km grid
distributed
precipitation
input
Snow melt
input
INFILTRATION
ALGORITHM
RUNOFF
HYDRO-
GRAPH
Discretely routed
in and out
of bank flows
Routing length 3
Routing length 2
Routing length 1
Flood
inundation
modelling
Application
of alternative
routing techniques
Turbulent exchange of flow between
cross-section segments
THREE DIMENSIONAL
INUNDATION MAPS

Fig 1.3

Establishment of
Model Structure



OBJECTIVES FOR THIS REPORTING PERIOD

1. To ascertain the sensitivity of MILHY3, Fig 1.2, (in both hydrograph fit and inundated extent) to:

   i) variability in the physical parameters

   ii) model structure in terms of module components utilised
   (Achieved using the Fulda catchment see Section III)

2. Development of RMA-2 solutions to studies of the Fulda and Haune rivers in order to further investigate the roles of hydrologic and hydraulic models. The aim being to establish operational rules for the maximum utilisation of the these two types of model.

II LOGICAL DEVELOPMENT IN THE INCORPORATION OF HYDRAULIC TECHNIQUES

1. Identification Of Key Variables

The analytical technique developed by Ervine and Ellis (1987), (reported March 1988, and summarized in Fig 2.1 and 2.2) calculate velocities and hence discharge for channel and floodplain flows separately. Sensitivity analysis of discharge predictions to changes in selected variables, Fig 2.3, exposed the need to further investigate the handling of friction in the existing model, MILHY2, and consider how this may be improved.

2. Existing Incorporation Of Friction

Friction is considered to embody two roughness components, (Fig 2.4):

i) turbulent exchange between separate flow pathways or tubes

ii) surface roughness of the channel and floodplain.

MILHY2 incorporates only the second of these two components. It utilises the Manning equation and a reduction formula to reduce surface friction as flow depth increases, as reported earlier (March 1987), and illustrated in Fig 2.5. When applied to overbank conditions with the geometries found typically in the Fulda catchment, negative discharge computations can result.

3. Incorporation Of Turbulent Exchange

Chow (1959) suggested that redefinition of the area and wetted perimeter terms may be undertaken to provide an improved discharge based on the Manning formula, incorporating some function of turbulence without increasing the data requirements. As reported in November 1987, this technique does make a significant impact on the outflow hydrograph and reduces predicted flow rates. Knight and Hamed (1983) tested all four of Chow's suggested methods against a flume study, Table 2.1, and concluded that Method 3 best predicts discharge.

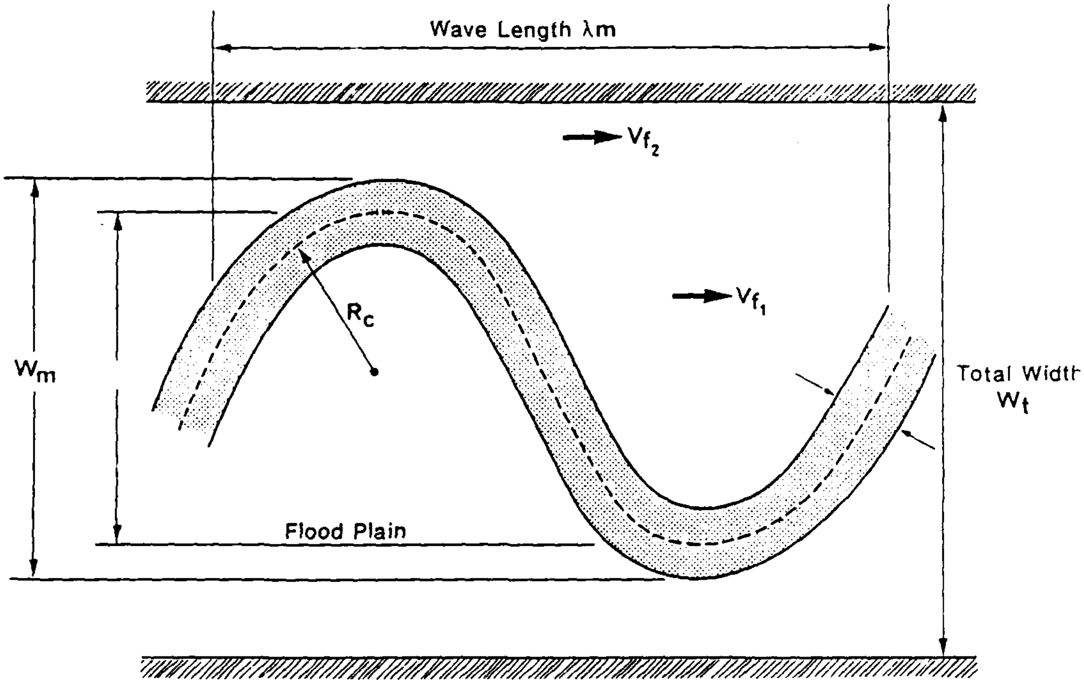


Fig 2.1a

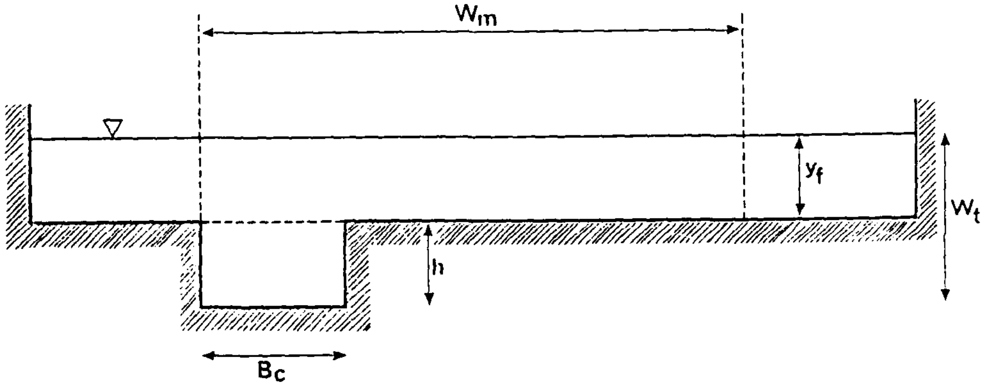


Fig 2.1b

Fig 2.2

CHANNEL

$$\frac{\lambda_c}{4} \cdot \frac{r\lambda_m}{R} \cdot \frac{V_c^2}{2g} + \frac{2.86\lambda_c^{\frac{1}{2}} + 2.07\lambda_c}{0.565 + {}_c} \cdot \frac{R}{R_c}^2 \cdot \frac{r\lambda_m}{R} \cdot \frac{V_c^2}{2g} = S_o\lambda_m$$

FLOOD PLAIN WITHIN

MEANDER BELT

$$\frac{\lambda_f}{4} \cdot \frac{1}{y_f} \cdot \frac{V_{f1}^2}{2g} (W_m Y_m - \lambda_m B_c r) +$$

$$r\lambda_m \frac{V_{f1}^2}{2g} \sin\bar{\theta} \left(\left[1 - \frac{y_f}{yc} \right]^2 + C_1 \right) = S_o\lambda_m W_m$$

REMAINING FLOODPLAIN

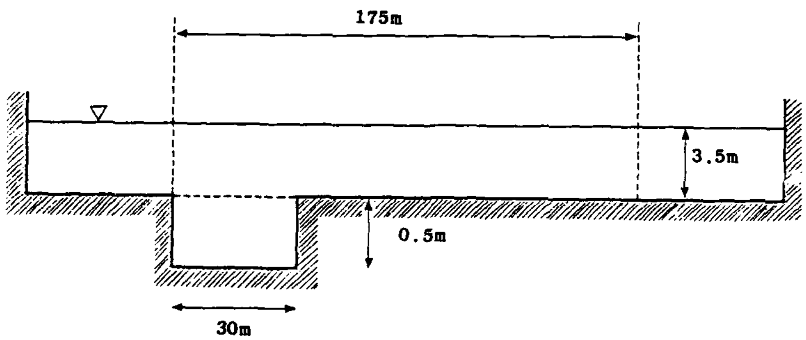
$$\frac{\lambda_f}{4} \cdot \frac{1}{y_f} \cdot \frac{V_{f2}^2}{2g} = S_o$$

$$Q = V_c(B_c h) + V_{f1}(y_f W_m) + V_{f2} y_f (W_t - W_m)$$

Fig 2.3

Change in Q : Sensitivity of Ervine & Ellis equations

% change in variable	-30%	-5%	+5%	+30%
Slope	-19	-2	+3	+13
Channel friction	+35	+4	-3	-17
Flood plain friction	+15	+2	-1	-9



ROUGHNESS COMPONENTS

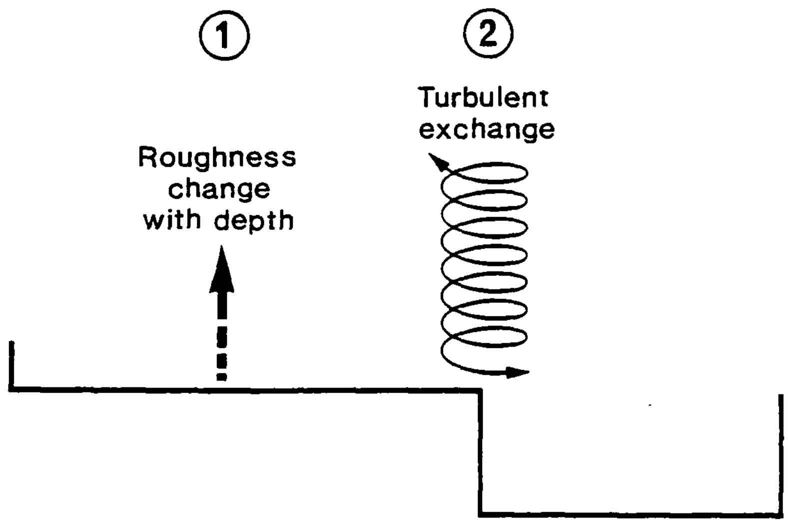


Fig 2.4

MILHY2 roughness reduction formula :

$$n' = n - 0.0025R$$

Rating curve valley section

Water Surface Elev.	Flow area Sq ft	Flow rate CFS $(x10^3)$
591.88	86.4	0
595.45	299.6	1
599.02	573.3	3
602.59	1030.0	7
606.16	4106.6	12
609.73	8436.7	63
613.30	12920.8	256
616.86	18078.9	35615
620.43	23984.5	-54
624.00	30582.6	-327

Fig 2.5

This method assumes a trapezoidal shear face between channel and floodplain flows.

TABLE 2.1

METHOD	ERROR: $\frac{\text{PREDICTED Q}}{\text{PREDICTED Q}} \times 100$
1 (MILHY2)	+ 25%
2	+ 9.97%
3	+ 7.38%

4. Development Of Multiple Routing Reach Pathways

In MILHY2, the out-of-bank path length for flood routing purposes is computed (in common with many other models such as HEC-1) by taking an average length between floodplain and channel segments. As Fread (1976) suggested, there is a tendency for floodplain flows to have a shorter path length; a 30% reduction is usual in mature, meandering channels. Hydrograph predictions are improved by multiple routing pathways provided these two criteria are met:

i) there is flowing water on the floodplain, not merely storage.

ii) the floodplain flow path is reduced by 30%.

Discrete pathways for floodplain and channel flows have therefore been introduced, (see the November 1987 report).

5. Comparison Of MILHY2 And RMA-2

There are two main reasons for such a comparison:

i) RMA-2 is taken to be the best currently available two dimensional hydrodynamic model. It therefore can be used to generate outflow hydrographs and inundation predictions for flood events for which only limited field data is available.

ii) It allows a direct comparison on the operational application of the hydrologically based MILHY3 with its pseudo-hydraulic modules, and a hydraulic model, RMA-2.

III SENSITIVITY ANALYSIS OF MILHY3

The objective of the sensitivity analysis was to determine the variation in hydrograph fit and inundated extent stemming from:

i) variability in the physical parameters and
ii) model structure (which module components are utilised), in the routing procedures. (The runoff generation scheme was not utilised.)

Comparisons were made using the Fulda database, Fig 3.1, on the Fulda river between Bad Hersfeld and Rotenburg, a reach of approximately 12 miles. Field hydrographs and inundation maps for the 1 in 10 year event were available, as well as sufficient data to determine the magnitude of other return period events.

Results

Fig 3.2 shows the 1 in 10 year event hydrographs with observed inflow as Bad Hersfeld and observed outflow at Rotenburg, with bankfull at Rotenburg being 6321.3 cfs. The travel time of the peak is approximately 9 hours, and the peak flow attenuates 700 cfs.

Fig 3.3 shows predicted outflow from MILHY2, (the original model with no hydraulic modules). The predicted travel time of the peak flow is only 6 hours whilst, the hydrograph magnitude is too small.

Fig 3.4 illustrates a MILHY3 model incorporating the cross-sectional redefinition method identified by Knight (KNIGHT 3). The inclusion of turbulent exchange seems to improve the timing of the hydrograph only slightly. More significantly, this method redefines the cross-section, thus the predicted peak discharge of 11318 cfs no longer produces out-of-bank flow at the downstream station (Rotenburg).

Fig 3.5 illustrates MILHY3 with multiple routing reach pathways, where the floodplain reach length has been reduced by 30%. This seems to produce a 'safe' prediction in that the

peak flow is slightly overestimated and slightly too early.

In terms of inundation, Fig 3.6, shows that all three approaches under estimated the extent of flooding. This is a product of the accuracy of the generated rating curve especially as in the model including multiple routing, the hydrograph peak was well predicted.

In the 1 in 100 year event, Fig 3.7 and 3.8, similar results are obtained. The incorporation of turbulent exchange (KNIGHT 3), appears to increase the roughness to too great an extent, whilst multiple routing gives a prediction sooner and larger than MILHY2.

Conclusion Of The Sensitivity Analysis

The results are summarized in Tables 3.1 and 3.2. These suggest that:

i) In reach lengths of this scale, 12 miles, and with floodplain flows accounting for upto 80% at the peak of the 1 in 10 year event, the incorporation of turbulent exchange of flow between cross-sectional segments, does not seem to improve the predictive capability of MILHY.

ii) A more significant inclusion seems to be incorporation of multiple routing reach pathways, specifically where floodplain path lengths are reduced.

Currently multiple routing and turbulent exchange modules can not be incorporated together. It would seem that the dampening effects of turbulent exchange on the multiple routing predicted hydrograph may provide the a better forecast.

Errors in the inundation predictions have two causes:

i) In the incorporation of turbulent exchange the rating curve is generated from a simplistic symmetrical compound channel section.

ii) In the multiple routing reach application, errors are due to such a simplistic division of floodplain and channel flows. Water is apportioned into these segments at the

Fig 3.1

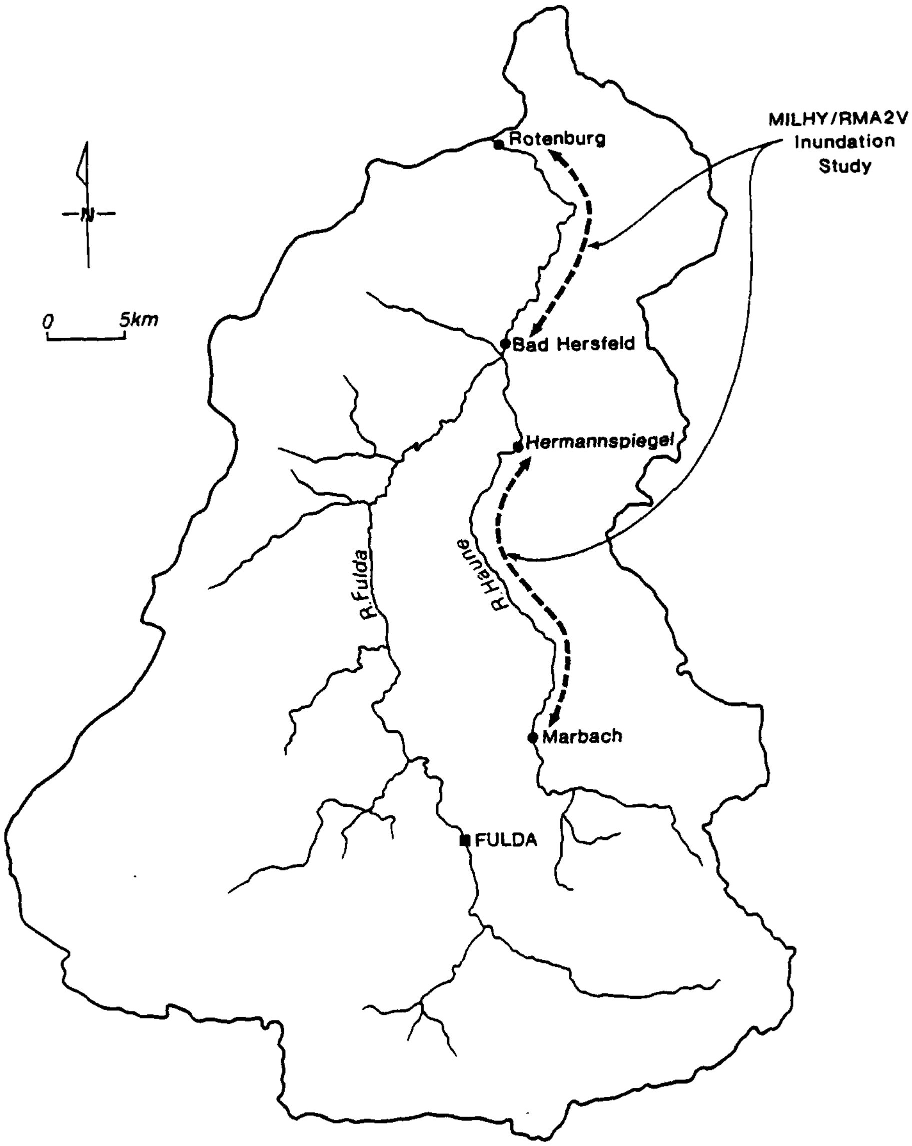

MILHY/RMA2V
Inundation
Study
Rotenburg
Bad Hersfeld
Hermannspiegel
Marbach
FULDA
R.Fulda
R.Haune
N
0
5km

Fig 3.2

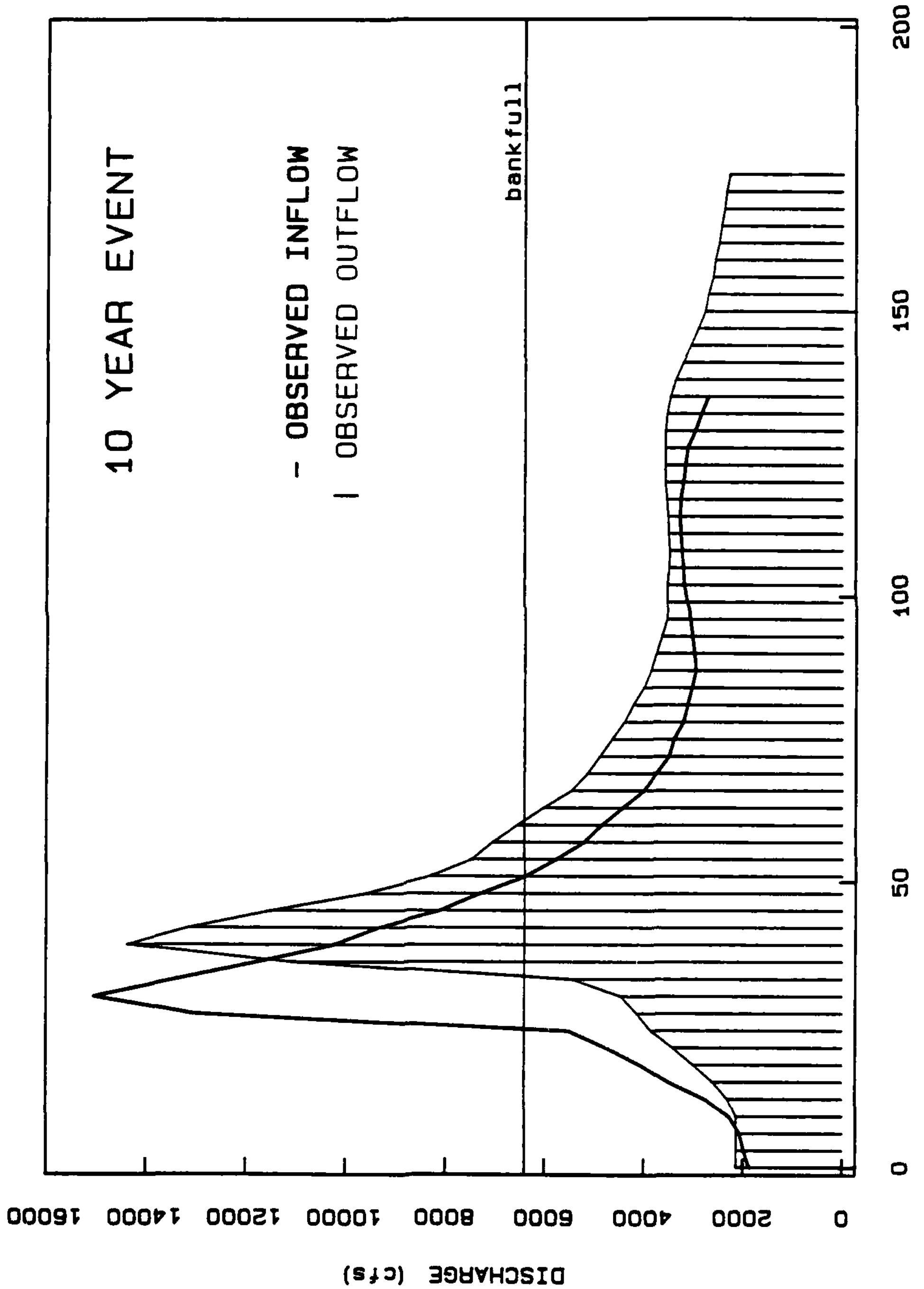

10 YEAR EVENT
- OBSERVED INFLOW
| OBSERVED OUTFLOW
bankfull
TIME (hours)
0
50
100
150
200
DISCHARGE (cfs)
0
2000
4000
6000
8000
10000
12000
14000
16000

Fig 3.3

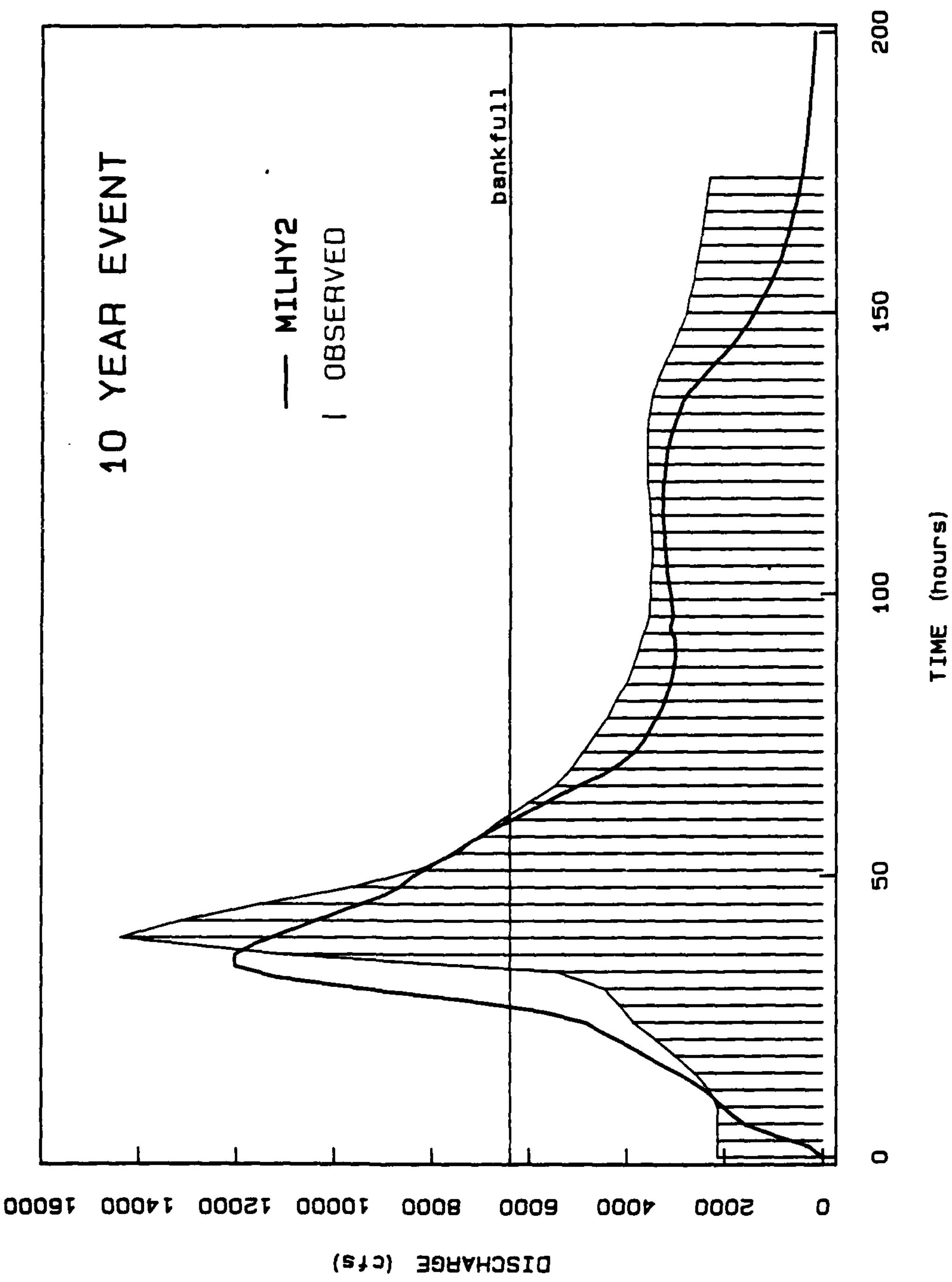

10 YEAR EVENT
— MILHY2
| OBSERVED
bankfull
DISCHARGE (cfs)
0
2000
4000
6000
8000
10000
12000
14000
16000
TIME (hours)
0
50
100
150
200

Fig 3.4

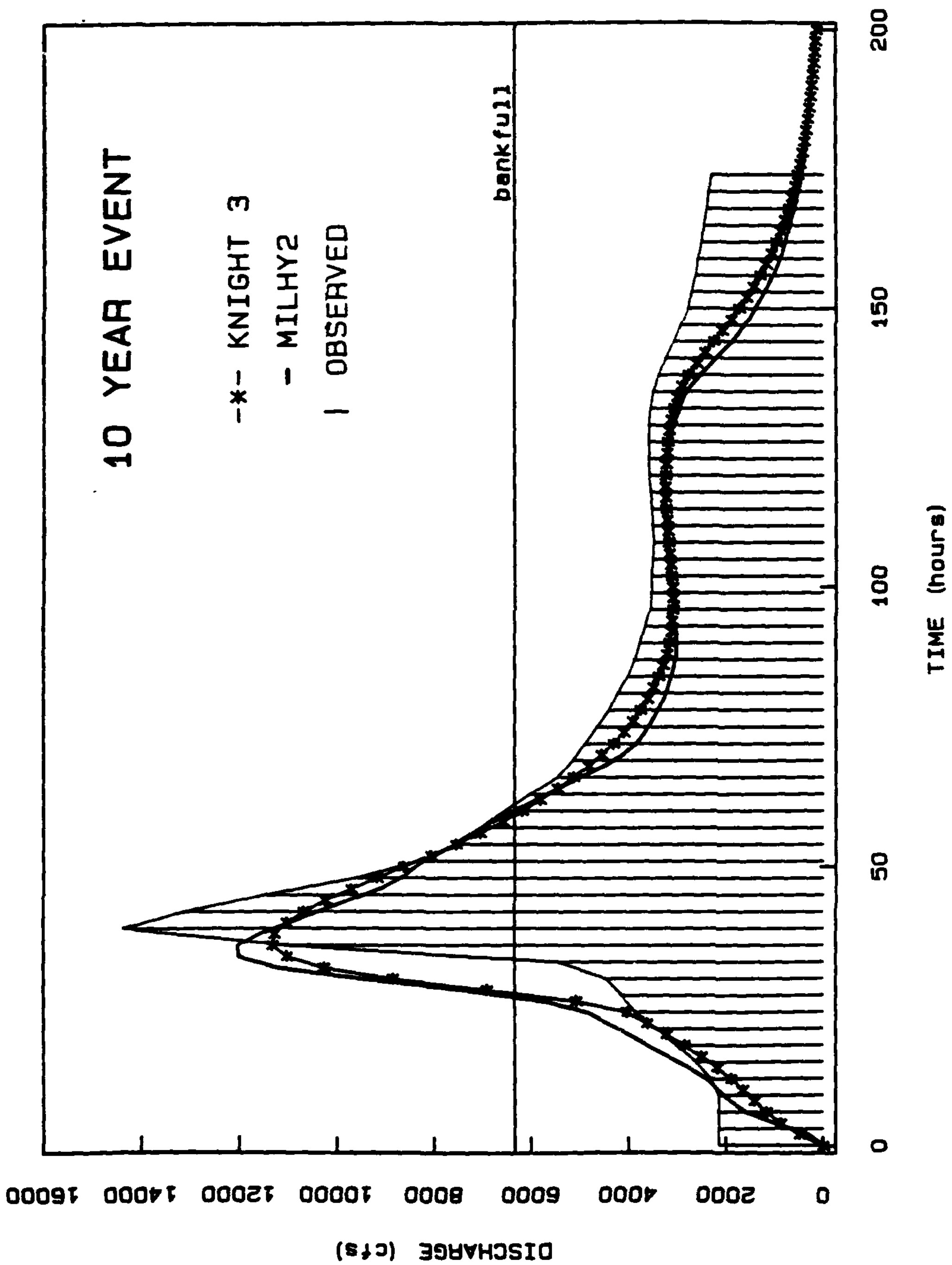

10 YEAR EVENT
-*- KNIGHT 3
- MILHY2
| OBSERVED
bankfull
DISCHARGE (cfs)
0
2000
4000
6000
8000
10000
12000
14000
16000
TIME (hours)
0
50
100
150
200

Fig 3.5

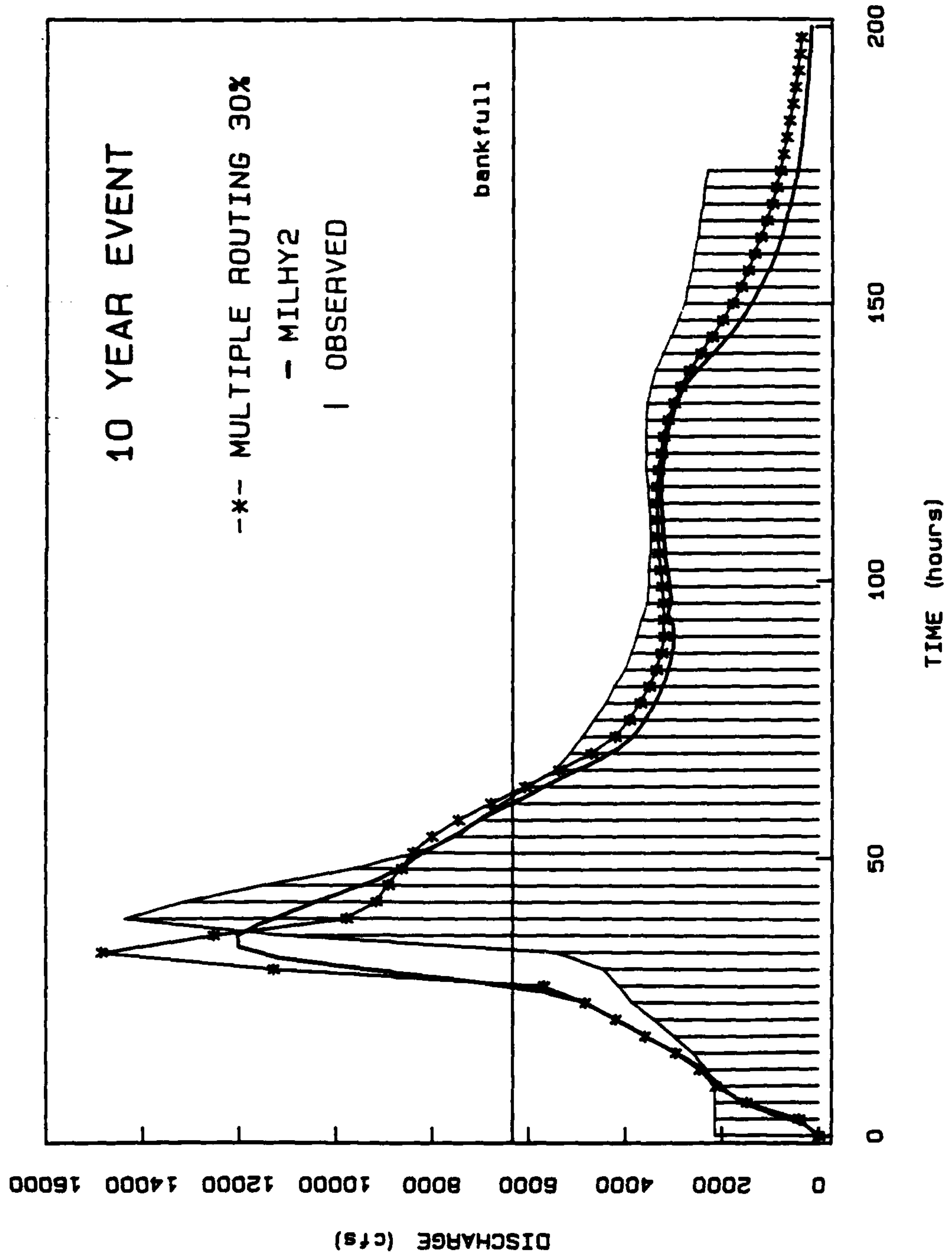
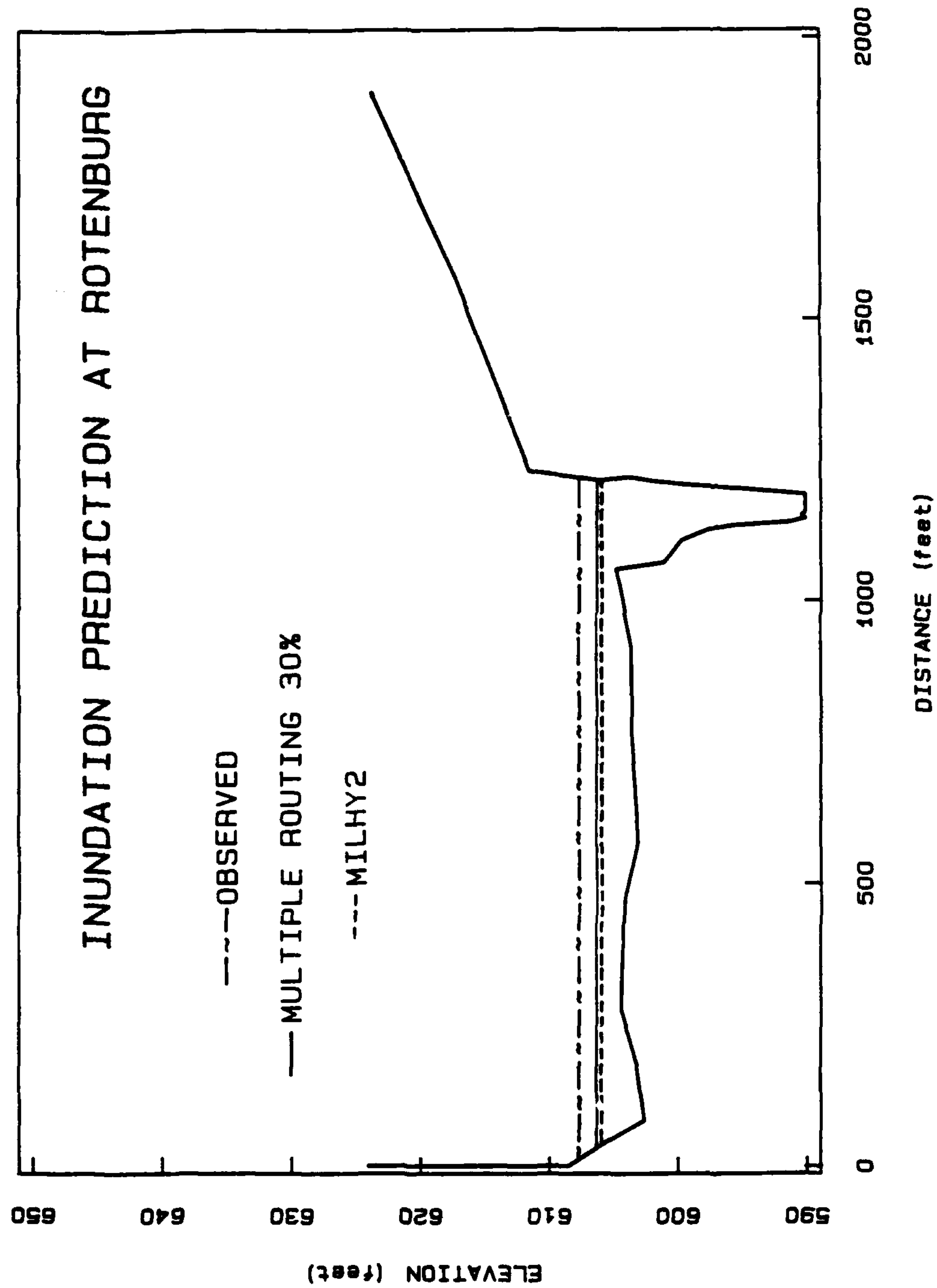

10 YEAR EVENT
-*- MULTIPLE ROUTING 30%
— MILHY2
| OBSERVED
bankfull
TIME (hours)
0
50
100
150
200
DISCHARGE (cfs)
0
2000
4000
6000
8000
10000
12000
14000
16000

Fig 3.6


INUNDATION PREDICTION AT ROTENBURG
---OBSERVED
—MULTIPLE ROUTING 30%
---MILHY2
ELEVATION (feet)
650
640
630
620
610
600
590
DISTANCE (feet)
0
500
1000
1500
2000

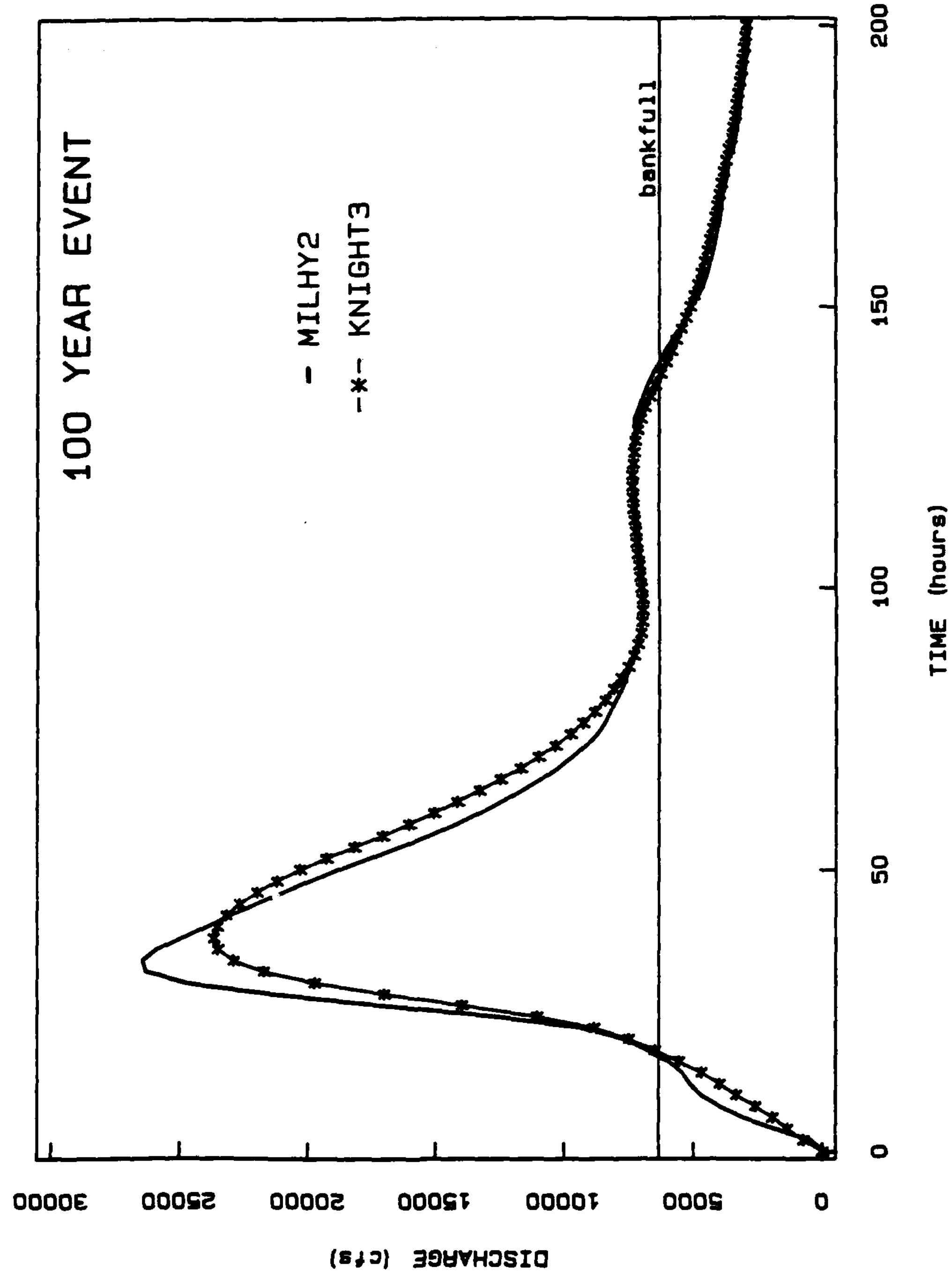

100 YEAR EVENT
- MILHY2
-*- KNIGHT3
bankfull
DISCHARGE (cfs)
0
5000
10000
15000
20000
25000
30000
TIME (hours)
0
50
100
150
200

Fig 3.7

Fig 3.8

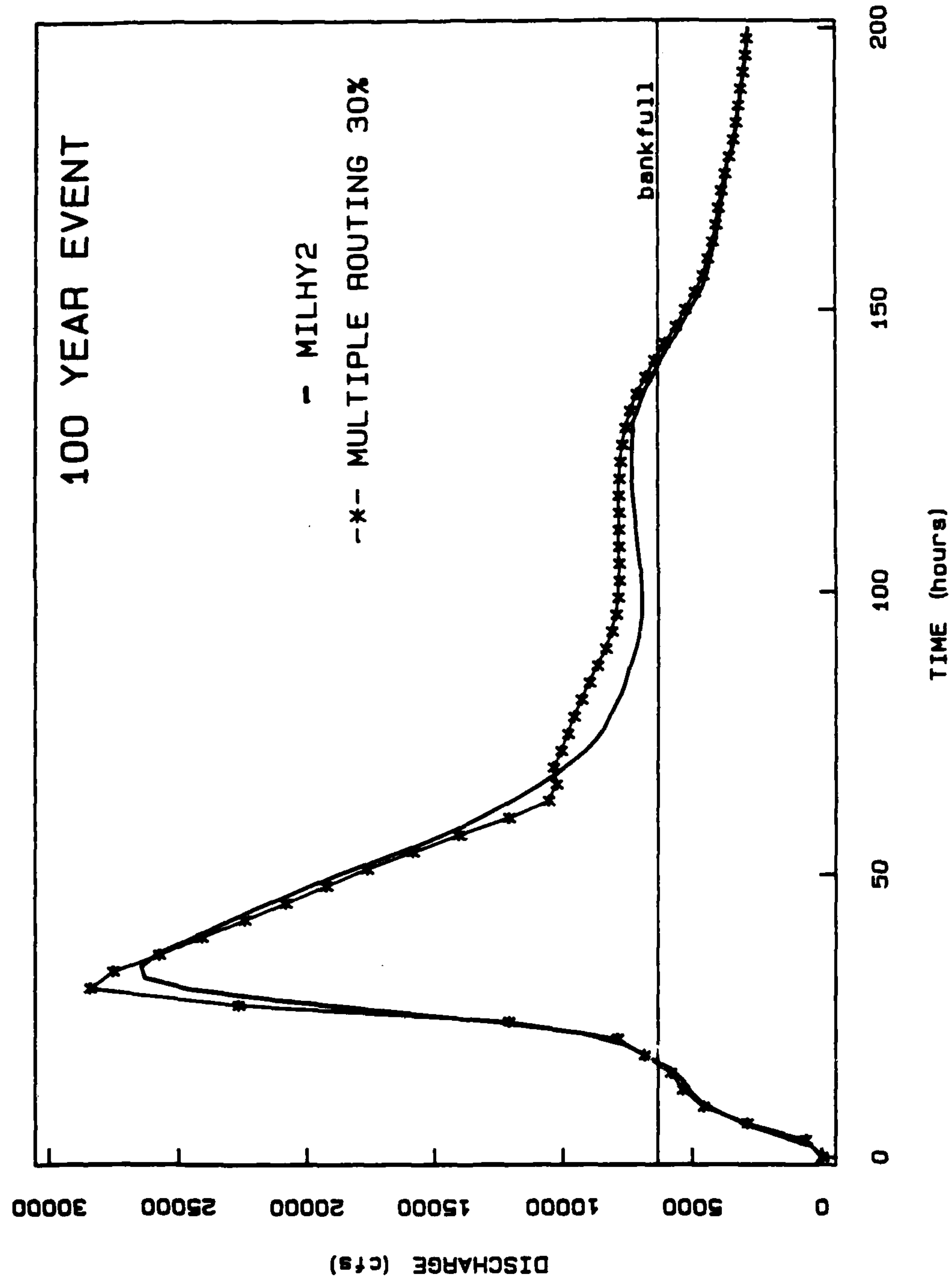

100 YEAR EVENT
— MILHY2
-*- MULTIPLE ROUTING 30%
bankfull
TIME (hours)
0
50
100
150
200
DISCHARGE (cfs)
0
5000
10000
15000
20000
25000
30000

TABLE 3.1

1 in 10 year event

	Peak discharge/elevation cfs	ft	Time to peak hours
OBSERVED	**14373**	**607.7**	**39**
MILHY2	12031	605.98	36
MILHY2(n')	10107	606.22	38
KNIGHT 1	10710	602.38	38
KNIGHT 2	10710	602.38	38
KNIGHT 3	11318	599.22	36
KNIGHT 4	10355	599.44	38
MULTIPLE ROUTING	12892	605.15	33
MULTIPLE ROUTING 30%	14850	606.34	33

TABLE 3.2

1 in 100 year event

	Peak discharge/elevation cfs	ft	Time to peak hours
MILHY2	26440	607.48	34
MILHY2(n')	23593	608.53	38
KNIGHT 1	23248	604.58	38
KNIGHT 2	23246	604.58	38
KNIGHT 3	23636	599.74	38
KNIGHT 4	21867	600.20	40
MULTIPLE ROUTING	26944.1	607.53	33
MULTIPLE ROUTING 30%	28393.8	607.37	30

upstream end of the reach using the rating curve, assuming no slope in the water surface in the cross-section. Errors occur as these proportions are not altered as the hydrograph is being routed down the reach.

IV RMA-2 APPLICATION

As stated earlier, (section III), there are two reasons for applying RMA-2 to the Fulda catchment:

i) to generate flow hydrographs for extreme events, thereby accepting the RMA-2 solution as the 'ground truth'.

ii) to investigate and attempt to distinguish between the operational roles of hydraulically based models, such as RMA-2, and hydrologic models, such as MILHY.

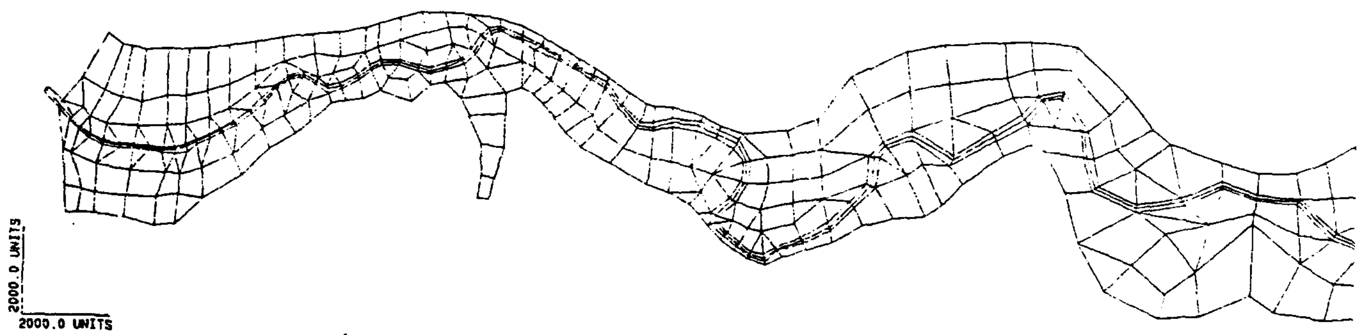
RMA-2 is a two-dimensional finite element model solving the Navier-Stokes equations for unstable flow conditions. Friction is incorporated using the Manning equation, and eddy viscosity coefficients define turbulence. Of specific interest in this application was the wetting and drying capability, where the model identifies elements that are dry in a particular solution and adjusts the mesh accordingly.

Application

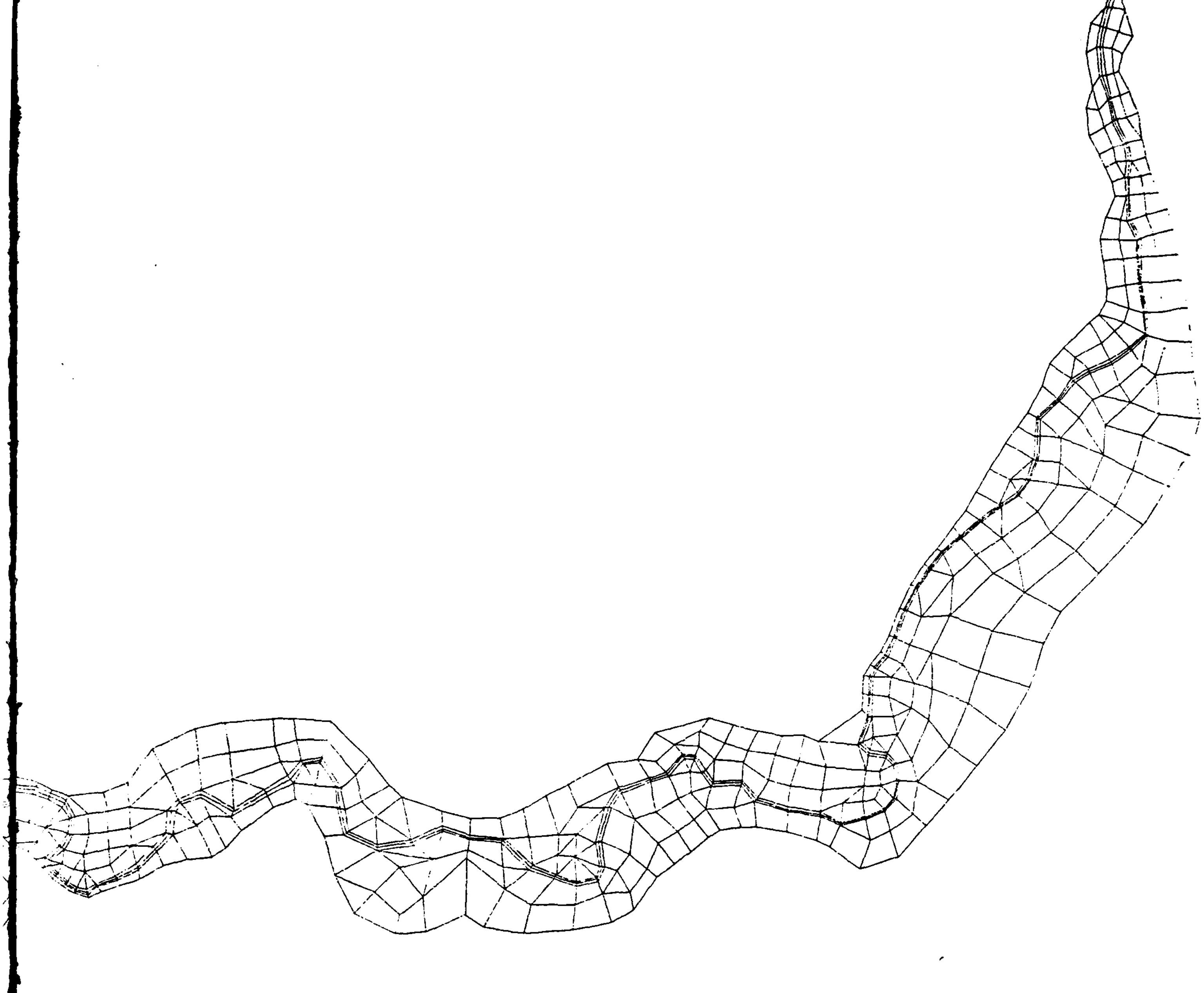
To coincide with the sensitivity analysis of MILHY3, RMA-2 was applied to the reaches identified in Fig 3.1. The Fulda reach, from Bad Hersfeld to Rotenburg, Fig 4.1, consists of approximately 900 elements and 2000 nodes and took 3 weeks to set up the mesh. Being the first application of RMA-2 at this scale, several problems were identified:

i) The major problem lay in the overall downstream fall in elevation; over a reach of approximately 12 miles the fall was 50 feet. To generate initial baseflow conditions a drawdown test is carried out from a reservoir of water covering the mesh, thus producing a friction slope. With such a long reach there was a tendency for the solution to fail as the downstream water elevation was lowered. This situation was remedied by using much smaller water elevation increments than used in previous applications. With initial conditions taking so long to generate this prompted a general reluctance to improve the network later as initial conditions must be

Fig 4.1



FULDA RIVER, MAY 1988.



1

2

recomputed.

ii) RMA-2 requires that the rating relationship being described is in the form of a single power function:

$$Q = A_1 + A_2(\text{ELEV-EO})^C$$

where A_1,A_2 and C are coefficients. In within bank conditions this may be sufficient, but in the out-of-bank conditions described in the Fulda catchment, the error in predicted elevation may exceed elevation changes originating from variability in the initial conditions. Fig 4.2 illustrates the best-fit single power function relationship used in this application, fitted just to the out-of-bank values, and the measured field relationship.

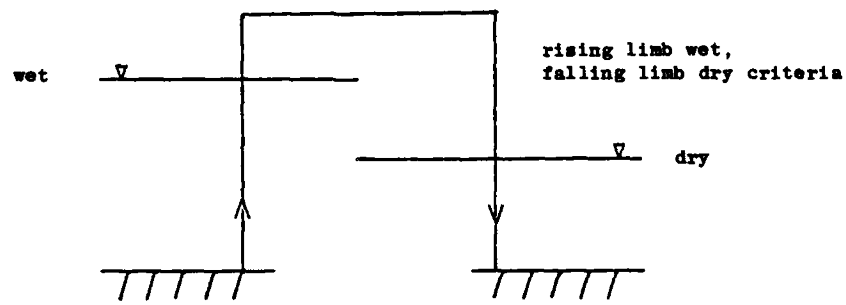
Application To The Fulda Catchment

The 1 in 10 year flood event was used, with the parameter values specified in Table 4.1. Figures 4.3 to 4.11 show the corresponding computed outflow hydrographs. From Table 4.1, it can be seen that three basic parameters were varied:

i) Initial roughness: used in the Manning equation. In previous applications Manning's 'n' values were lower than those recommended by Chow (1959). This is due to the incorporation of friction through turbulent exchange in RMA-2 via the eddy viscosity coefficients. Channel and floodplain roughness were separately identified by classifying two element types during the setting up of the mesh.

ii) Initial surface water elevation of baseflow prior to the start of the hydrograph rise - in practise the bankfull discharge.

iii) Wet/dry criteria; these are the criteria under which an element is defined as being either wet, and included in an iterative solution, or dry and excluded. The figure below illustrates the hysteretic effect of these criteria.



RESULTS available are the outflow hydrographs at Rotenburg, (Figs 4.3 to 4.11), and velocity vector diagrams for Runs 1,2,5 and 7, at bankfull and peak discharges, (Figs 4.12 to 4.15). The vector plots are used to identify the utility of the wet/dry algorithm in predicting inundation.

Figure 4.3, the outflow hydrograph from Run 1, shows that RMA-2 predicts too short a travel time. This stems from the generation of insufficient storage in the system, a possible cause of this being too high initial water surface conditions. For Run 2 therefore, the initial water surface elevation was reduced to 603.5 ft, i.e. from 7900 cfs to 5000 cfs. The drying criteria was also changed from 0.3 ft to 0.5 ft.

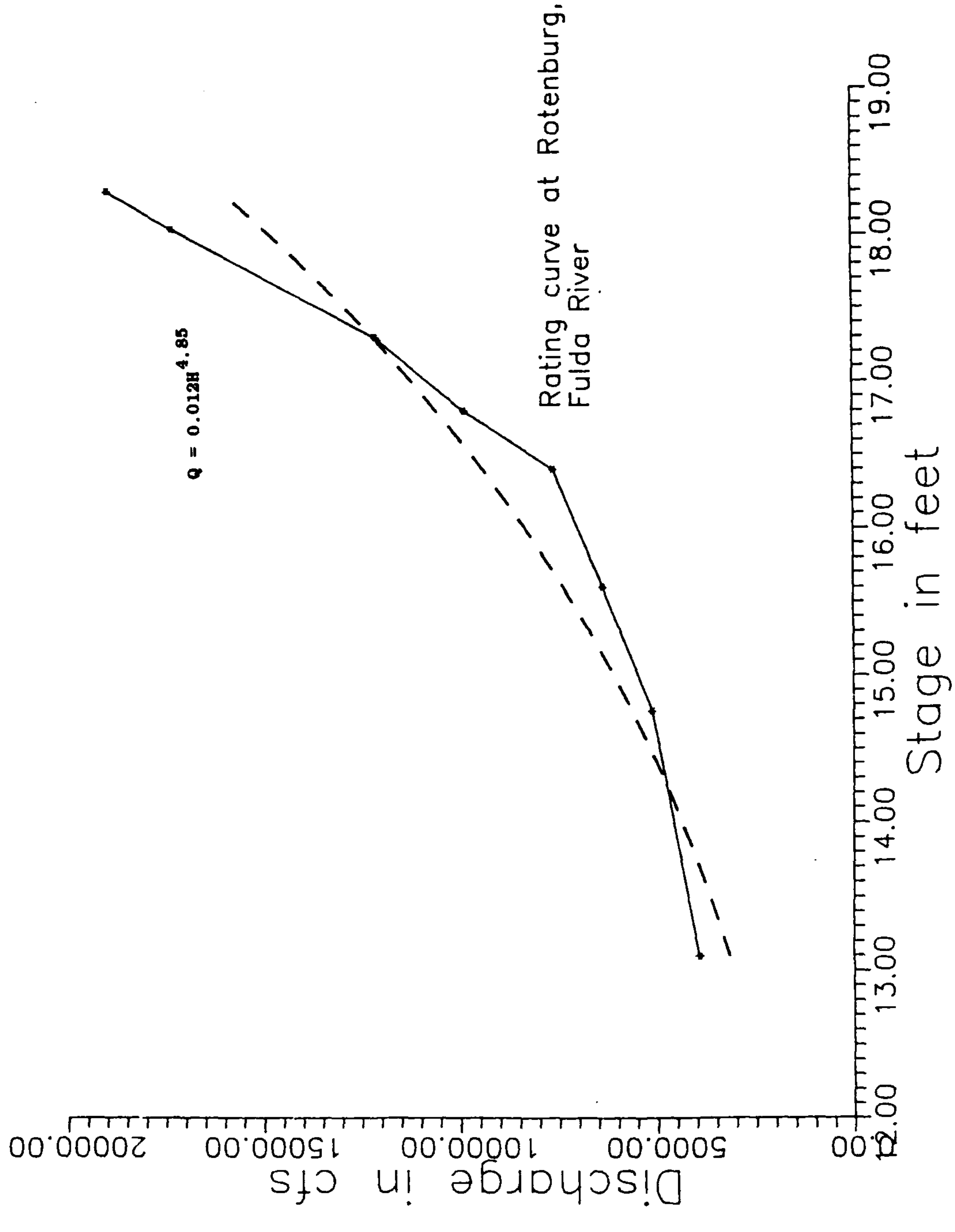
Comparison of Fig 4.3 and 4.4 shows however, that these measures failed to improve the travel time. This was probably because, as Fig 4.12b and 4.13b illustrate, the inundation patterns at maximum discharge vary little. One possible solution therefore, was to increase the roughness coefficients.

Thus in Run 3, the channel 'n' value was increased to 0.045 from 0.035, in an attempt to slow down the flood wave.

TABLE 4.1
Initial Conditions For RMA-2 Application

RUN	Initial roughness CH	Initial roughness FLD PL	Initial water surface elevation (feet)	Wet/dry criteria DRY	Wet/dry criteria WET
1	0.035	0.045	604.8	0.5	1.0
2	0.035	0.045	603.5	0.5	1.0
3	0.045	0.055	603.5	0.5	1.0
4	0.040	0.050	603.5	0.5	1.0
5	0.035	0.045	603.5	0.1	0.6
6	0.030	0.040	603.5	0.1	0.6
7	0.035	0.045	603.5	0.05	0.4
8	0.035	0.045	603.5	0.05	0.2
9	0.040	0.045	603.5	0.05	0.2

Fig 4.2


Rating curve at Rotenburg, Fulda River
Q = 0.012H^4.85
Stage in feet
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
Discharge in cfs
0.00
5000.00
10000.00
15000.00
20000.00

These conditions however, failed to produce a full solution. This was probably due to a channel element falling below the drying criteria.

From Runs 1 to 4 it was therefore concluded that roughness changes only affect the computation solution and not the timing of the hydrograph.

In an attempt to get more water stored in the floodplain elements, the wet/dry criteria were changed in Run 5 form 0.5/1.0 ft to 0.1/0.6 ft. Comparison of maximum discharge velocity vector plots (Fig 4.13b and 4.14b), shows that this may indeed be happening, especially in the downstream sections. There seemed to be more water on the floodplains.

Now that the water was distributed across the floodplain, the roughness coefficient for the floodplain was increased to slow the conveyance of this water, (Run 6). A further reduction of the wet/dry criteria in Run 7, seems at least to have the hydrograph moving in the correct direction. Figure 4.15b illustrates the more extensive inundation. Attempts to reduce the wet/drying criteria to zero caused to solution to fail.

Failure to significantly increase the travel time was considered to results from inadequate representation of the capacity of the channel. As the initial primary objectives were to examine out-of-bank conditions, and to minimise computation demands, it was considered satisfactory to describe the channel as **triangular**. The cross-sectional area was a still reasonable approximation in respect to the two known cross-sections at Bad Hersfeld and Rotenburg.

Results from Runs 1 to 9, strongly suggest that this geometrical approximation may be inadequate.

Confirmation of this interpretation is seen by examination of hydrographs from intermediate cross-sections with the reach, (Figs 4.16 to 4.20). The lack of variation in their form shows that cross-sectional geometric effects are dominant over spatially variable geometry effects, such as meandering and floodplain width changes.

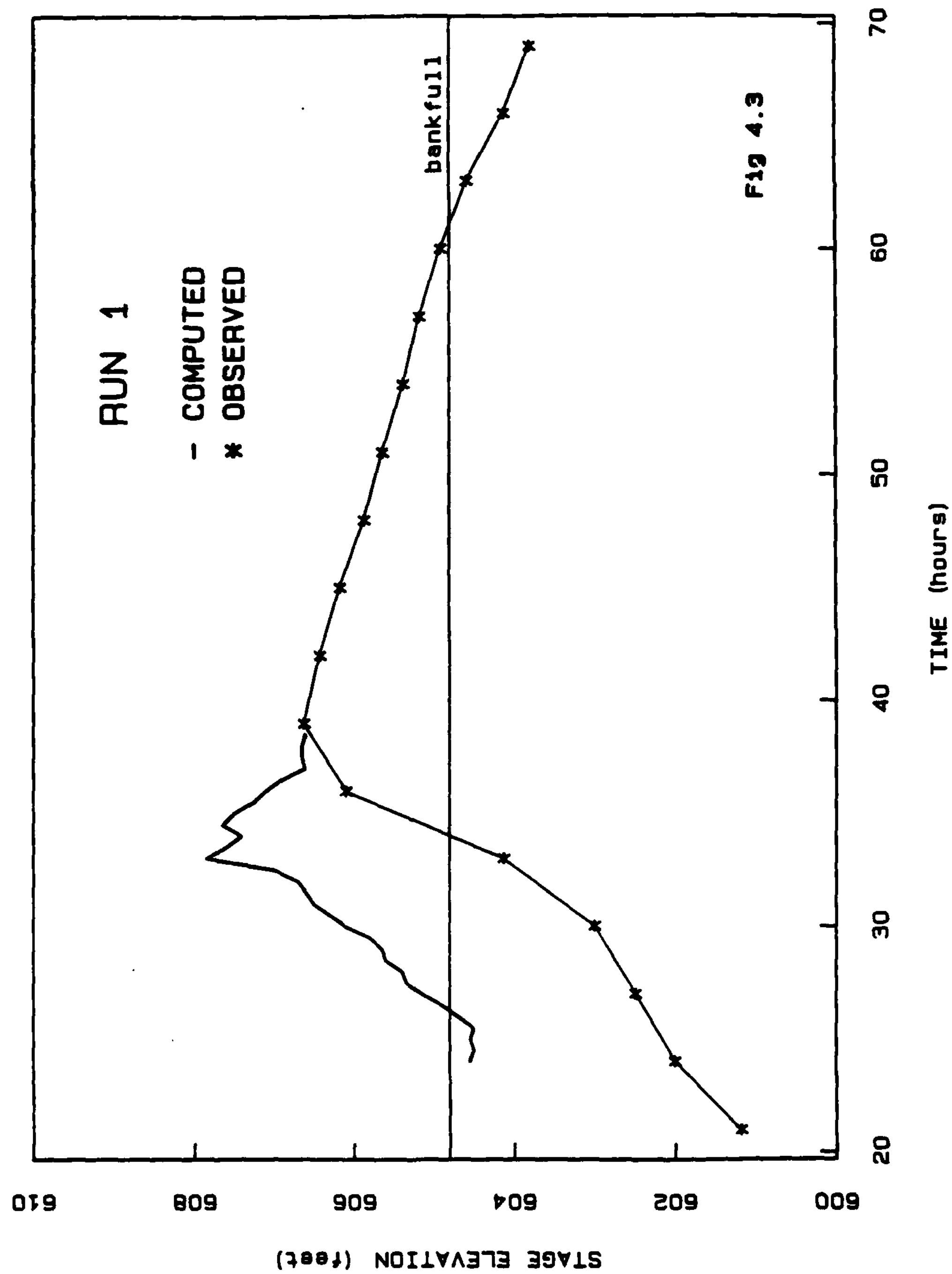
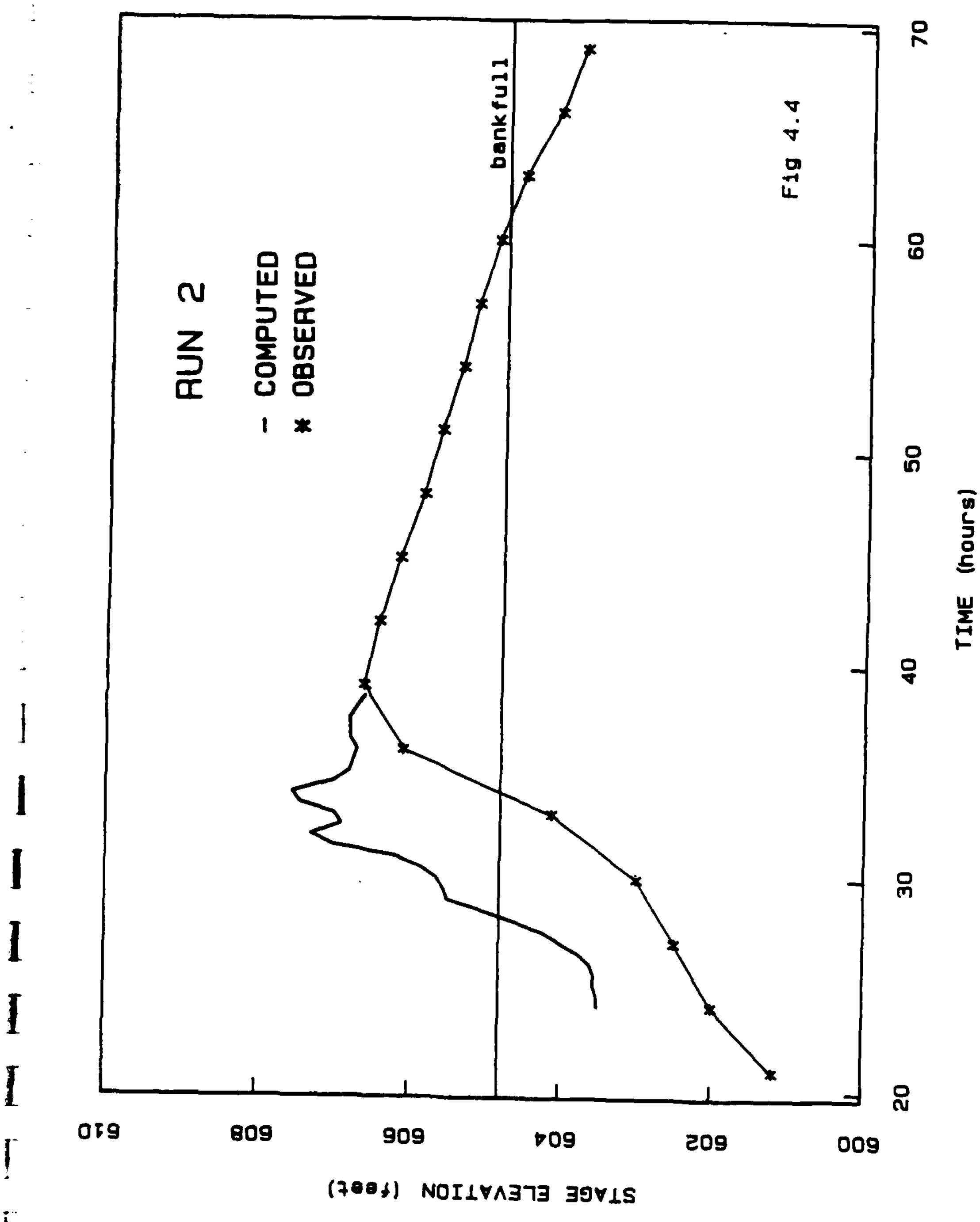

RUN 1
- COMPUTED
* OBSERVED
bankfull
STAGE ELEVATION (feet)
TIME (hours)
600
602
604
606
608
610
20
30
40
50
60
70

Fig 4.3


RUN 2
- COMPUTED
* OBSERVED
bankfull
Fig 4.4
STAGE ELEVATION (feet)
600
602
604
606
608
610
TIME (hours)
20
30
40
50
60
70

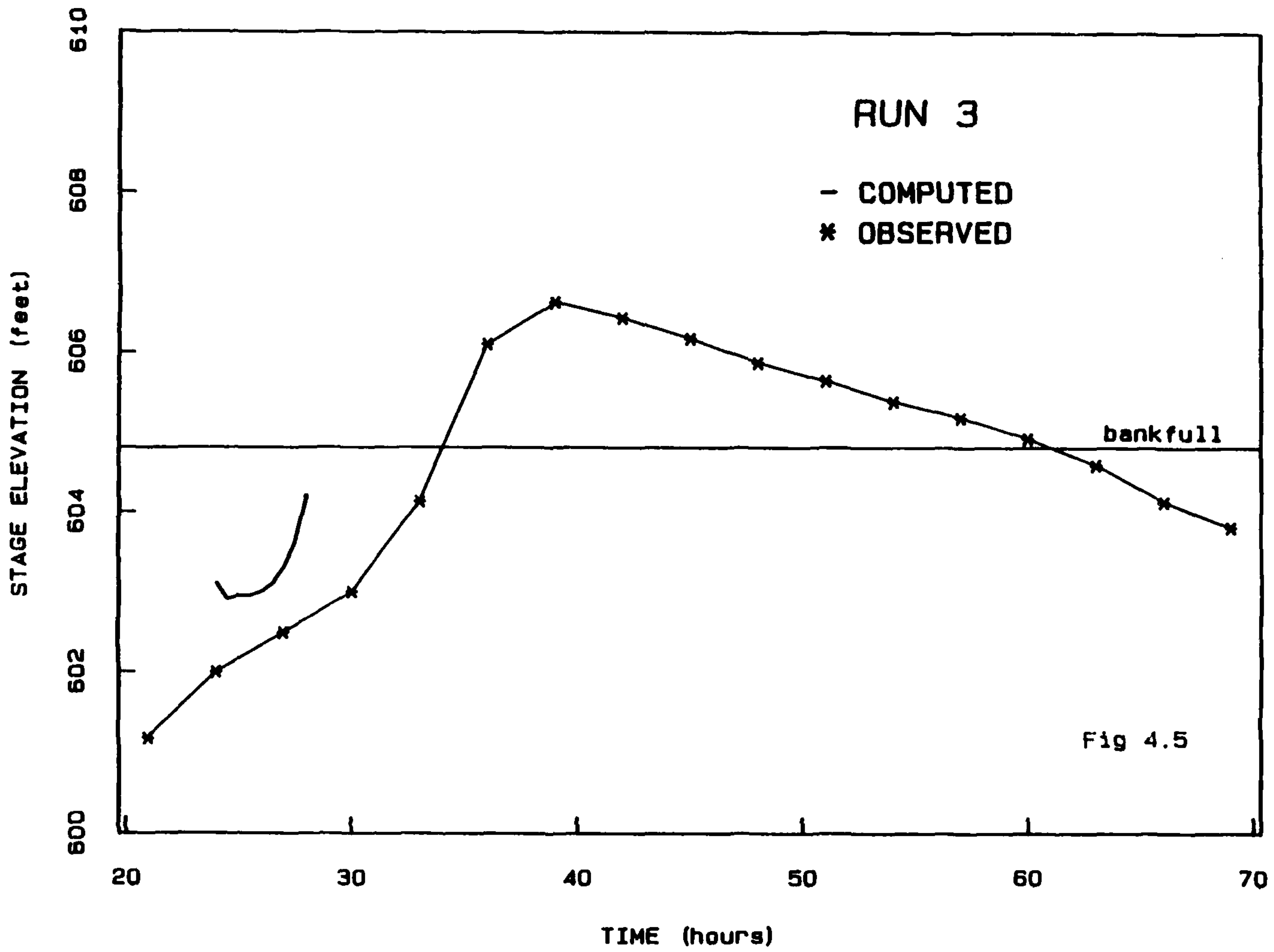

RUN 3
- COMPUTED
* OBSERVED
bankfull
STAGE ELEVATION (feet)
600
602
604
606
608
610
TIME (hours)
20
30
40
50
60
70

Fig 4.5

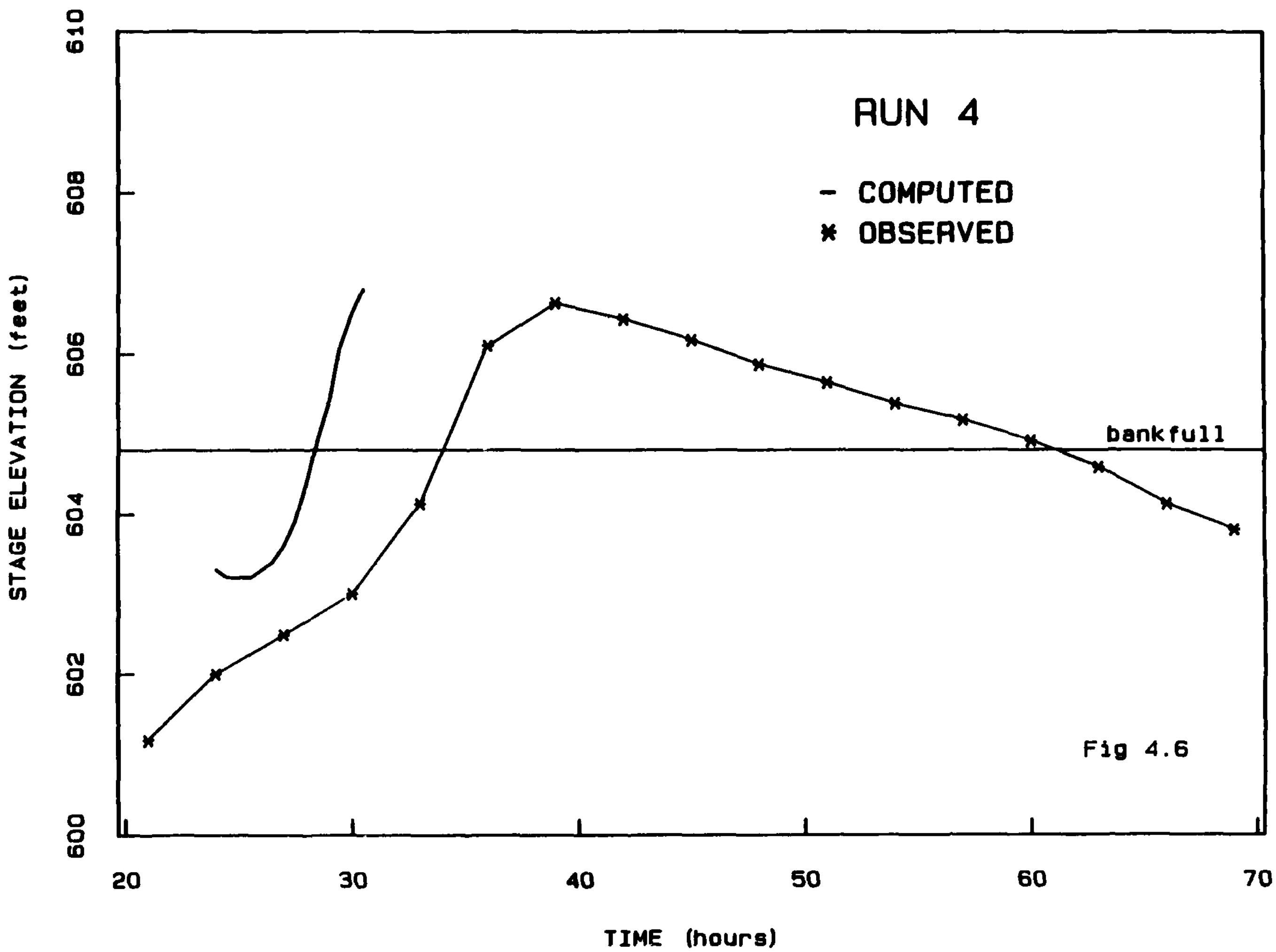
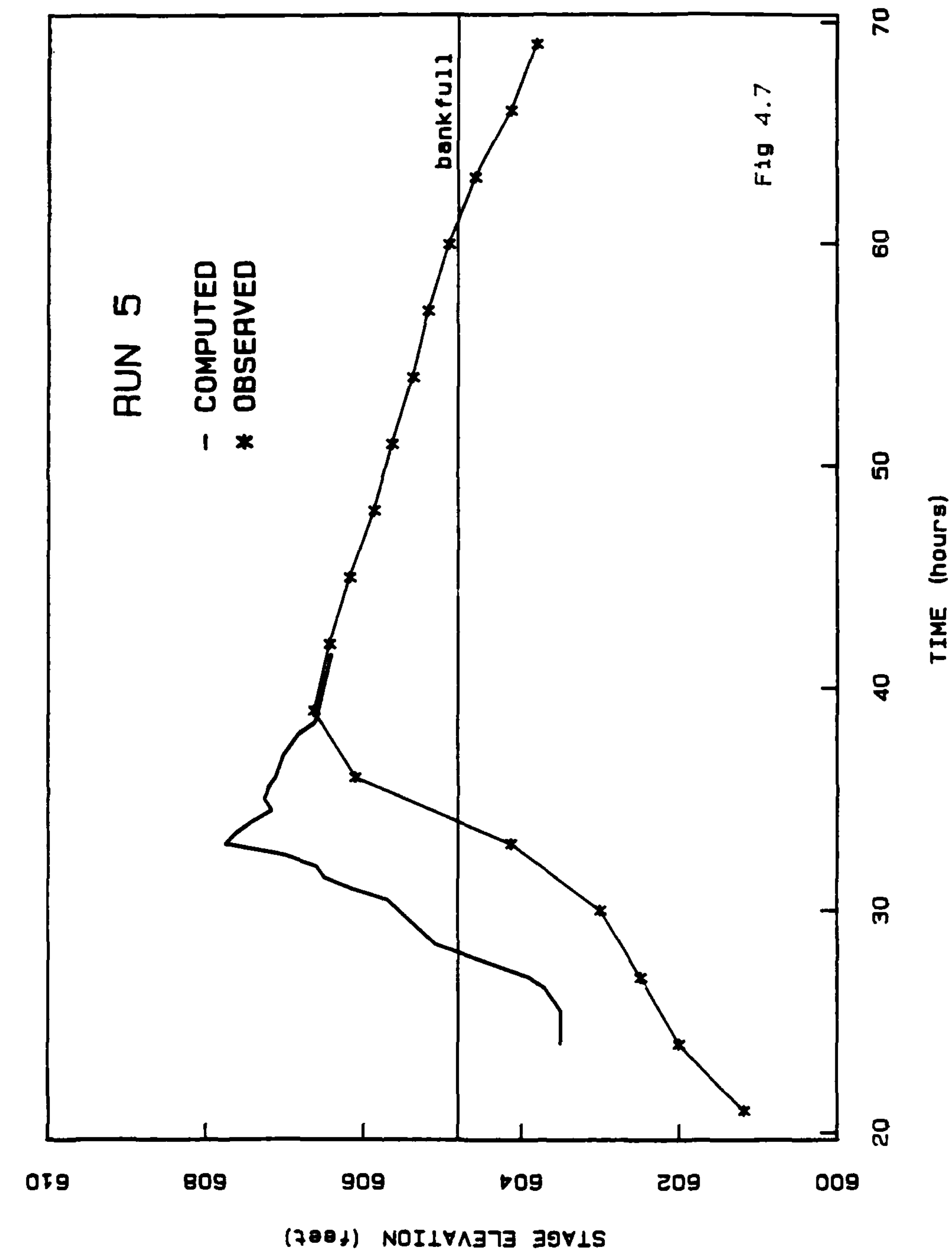

RUN 4
- COMPUTED
* OBSERVED
bankfull
STAGE ELEVATION (feet)
600
602
604
606
608
610
TIME (hours)
20
30
40
50
60
70

Fig 4.6


RUN 5
- COMPUTED
* OBSERVED
bankfull
STAGE ELEVATION (feet)
600
602
604
606
608
610
TIME (hours)
20
30
40
50
60
70
Fig 4.7

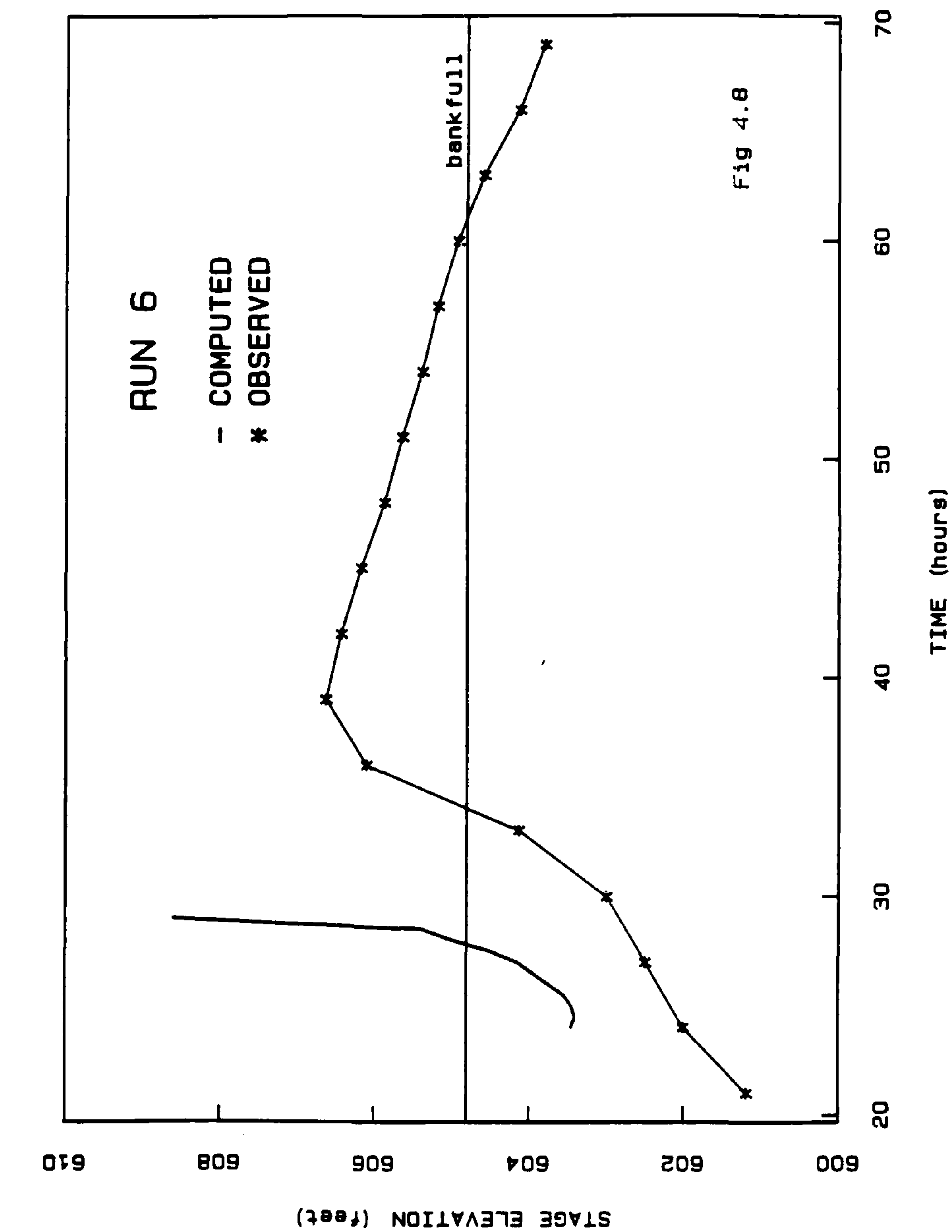
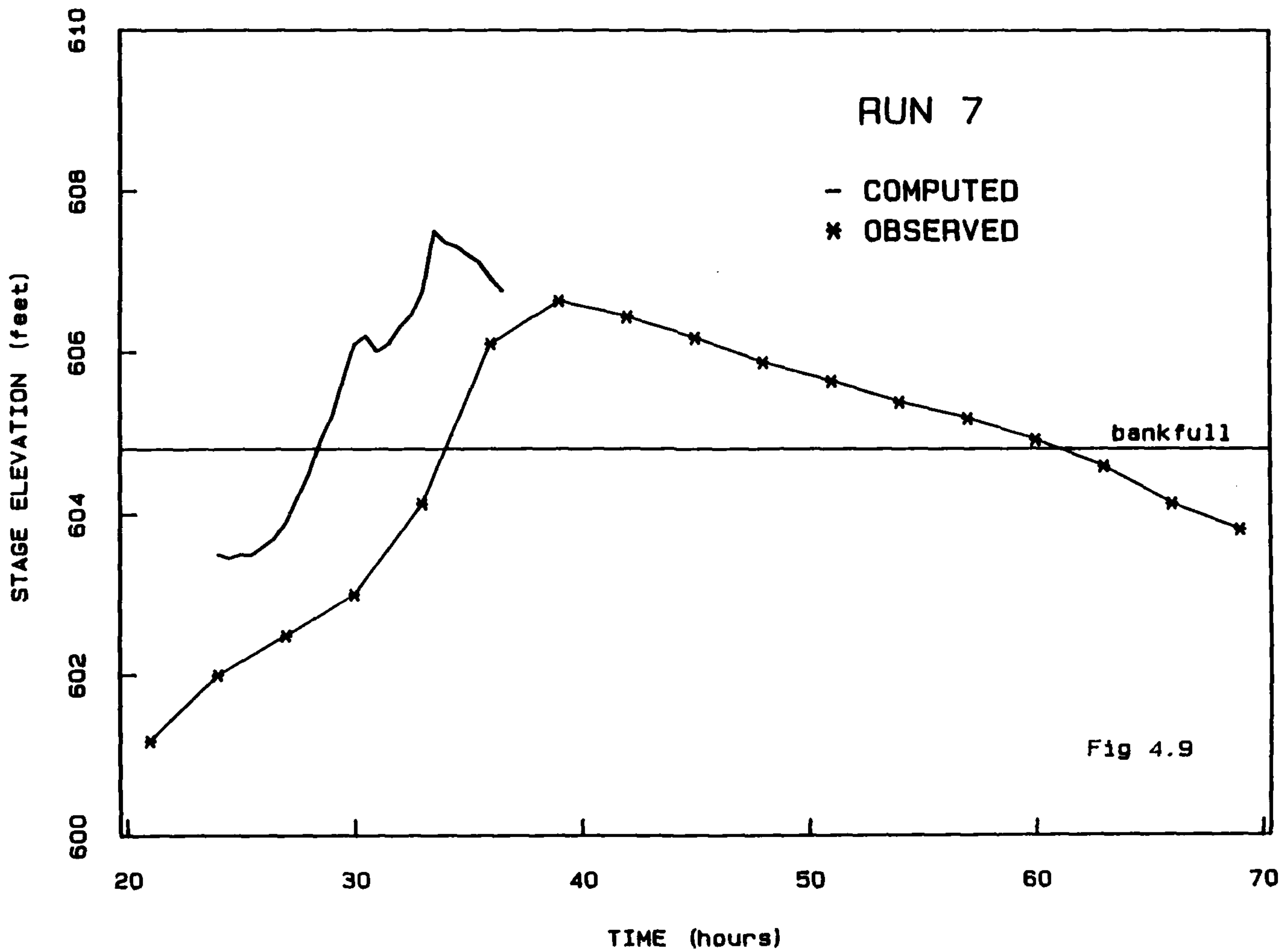

RUN 6
- COMPUTED
* OBSERVED
bankfull
TIME (hours)
20
30
40
50
60
70
STAGE ELEVATION (feet)
600
602
604
606
608
610

Fig 4.8


RUN 7
- COMPUTED
* OBSERVED
bankfull
Fig 4.9
STAGE ELEVATION (feet)
600
602
604
606
608
610
TIME (hours)
20
30
40
50
60
70

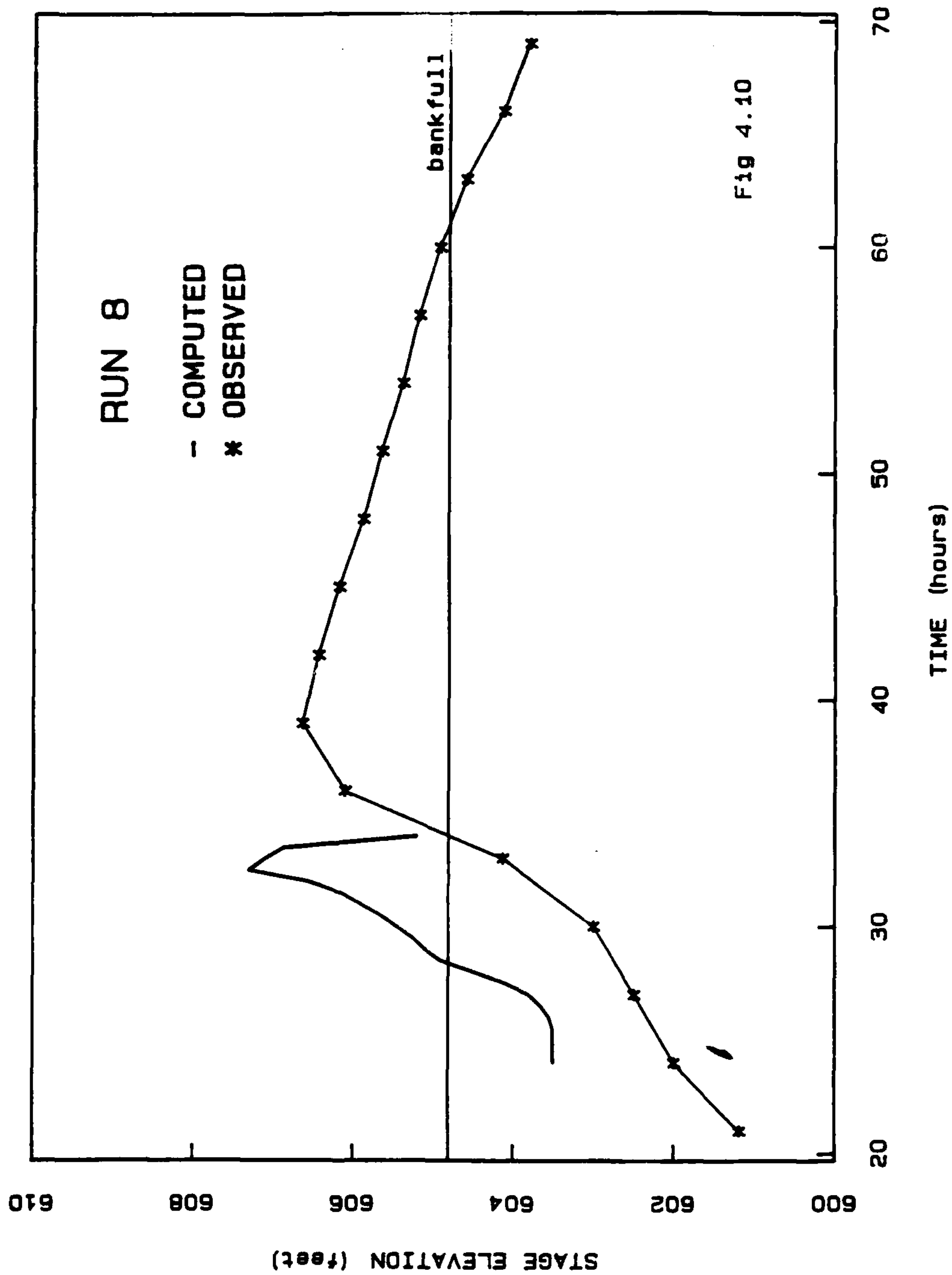

RUN 8
- COMPUTED
* OBSERVED
bankfull
STAGE ELEVATION (feet)
TIME (hours)
600
602
604
606
608
610
20
30
40
50
60
70

Fig 4.10

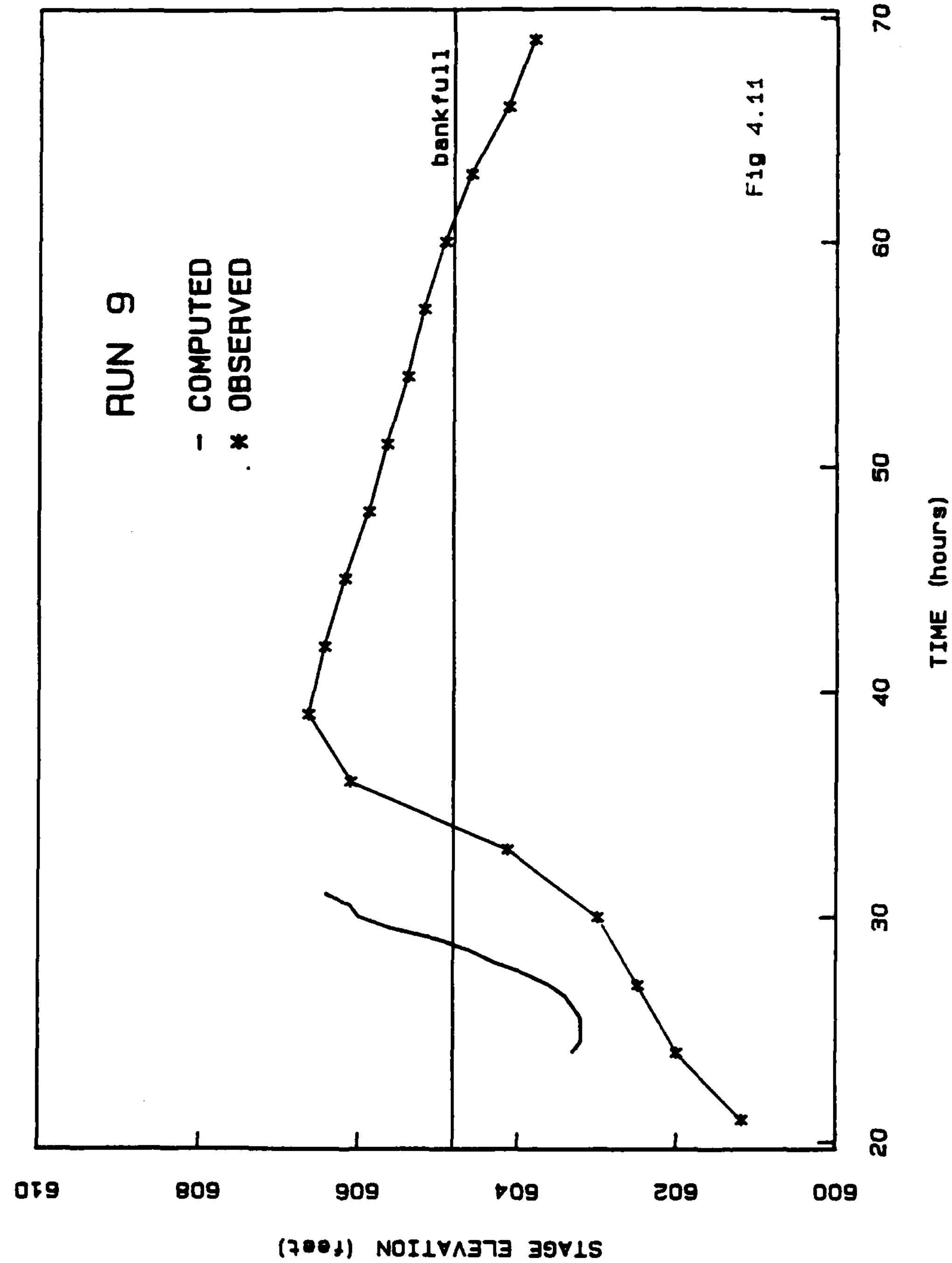
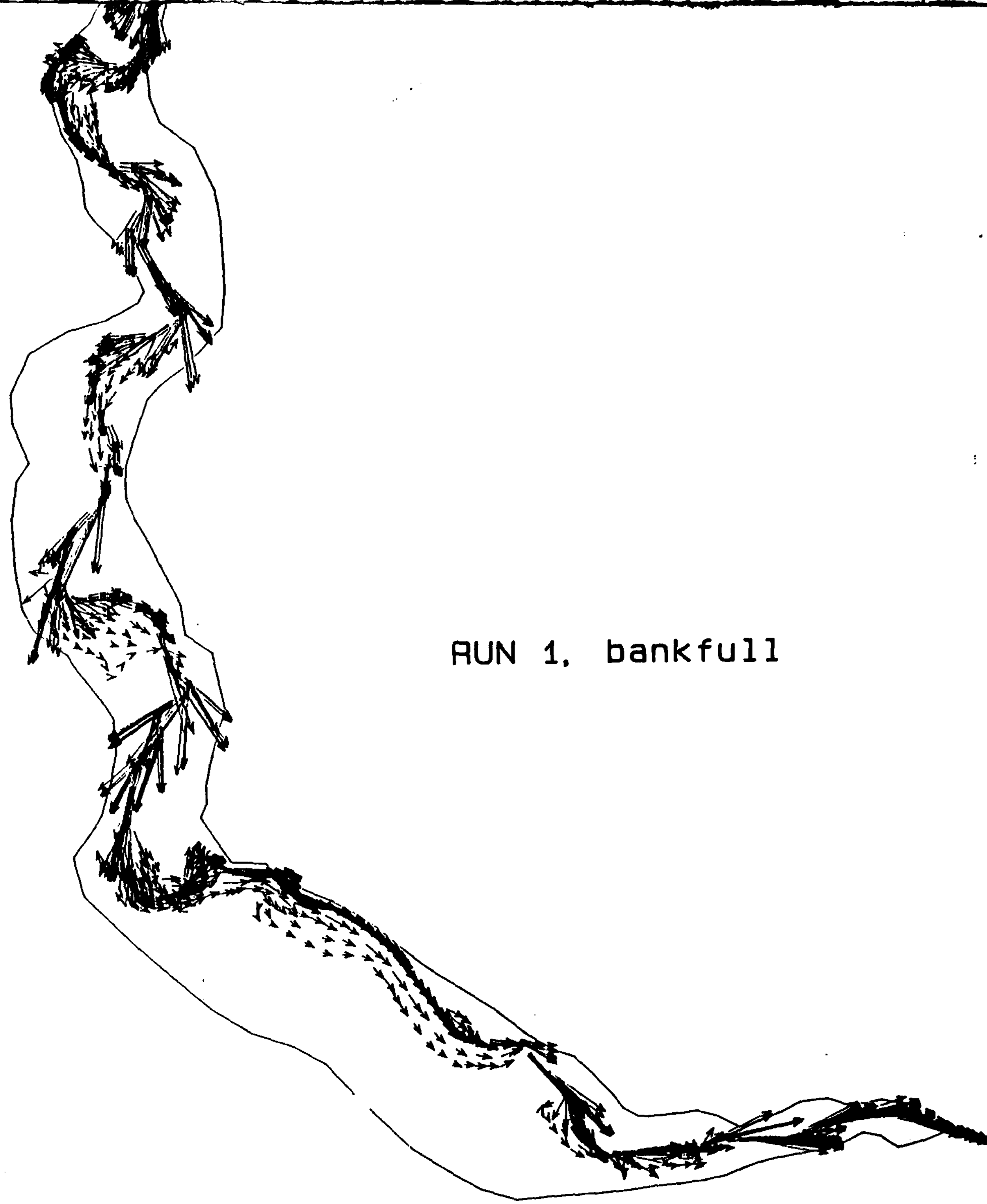

RUN 9
- COMPUTED
* OBSERVED
bankfull
STAGE ELEVATION (feet)
TIME (hours)
600
602
604
606
608
610
20
30
40
50
60
70

Fig 4.11

VELOCITY VECTOR PLOT

FIG 4.12a

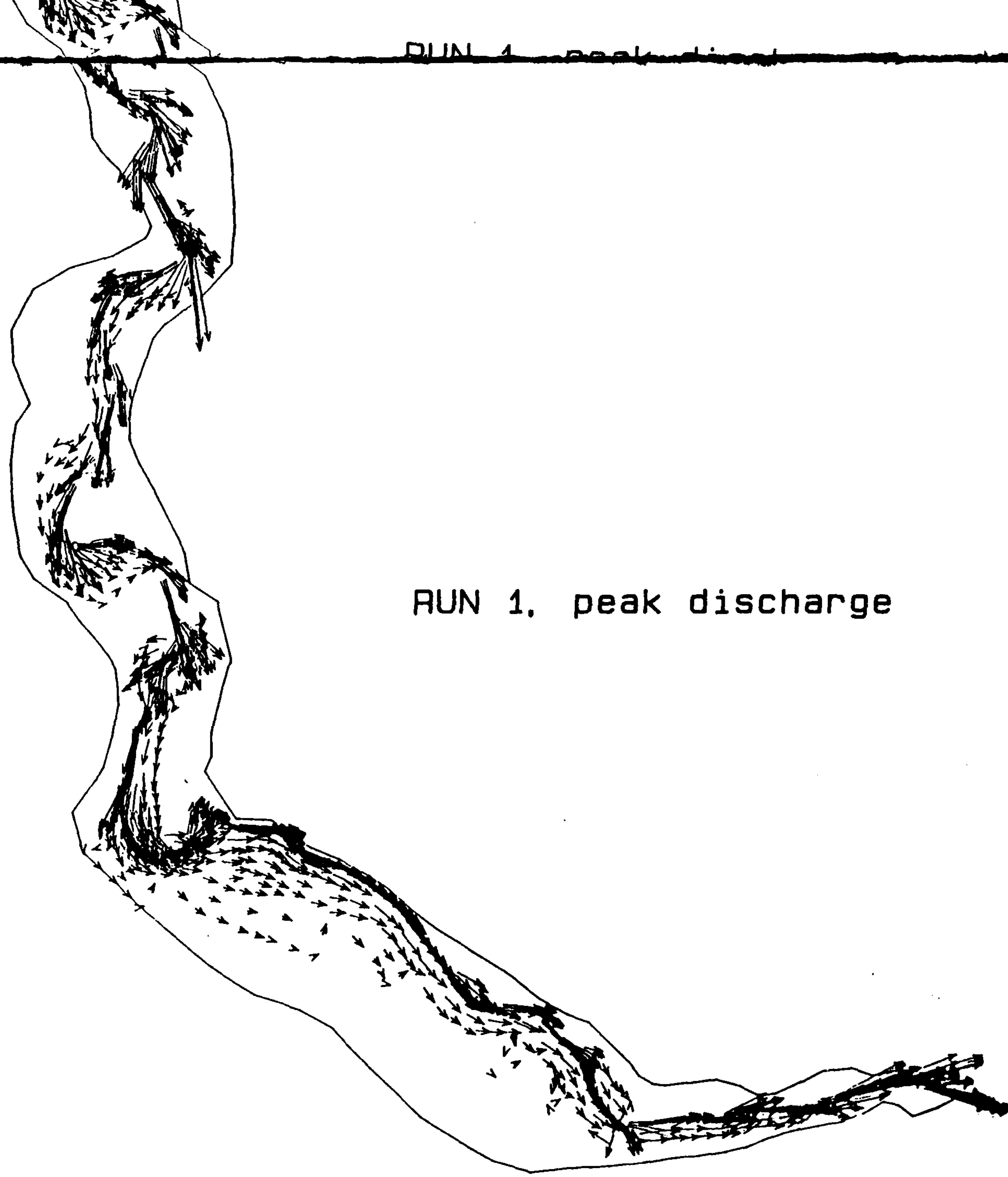
RUN 1, bankfull



RUN 1, bankfull

VELOCITY VECTOR PLOT

FIG 4.12b



RUN 1. peak discharge

2

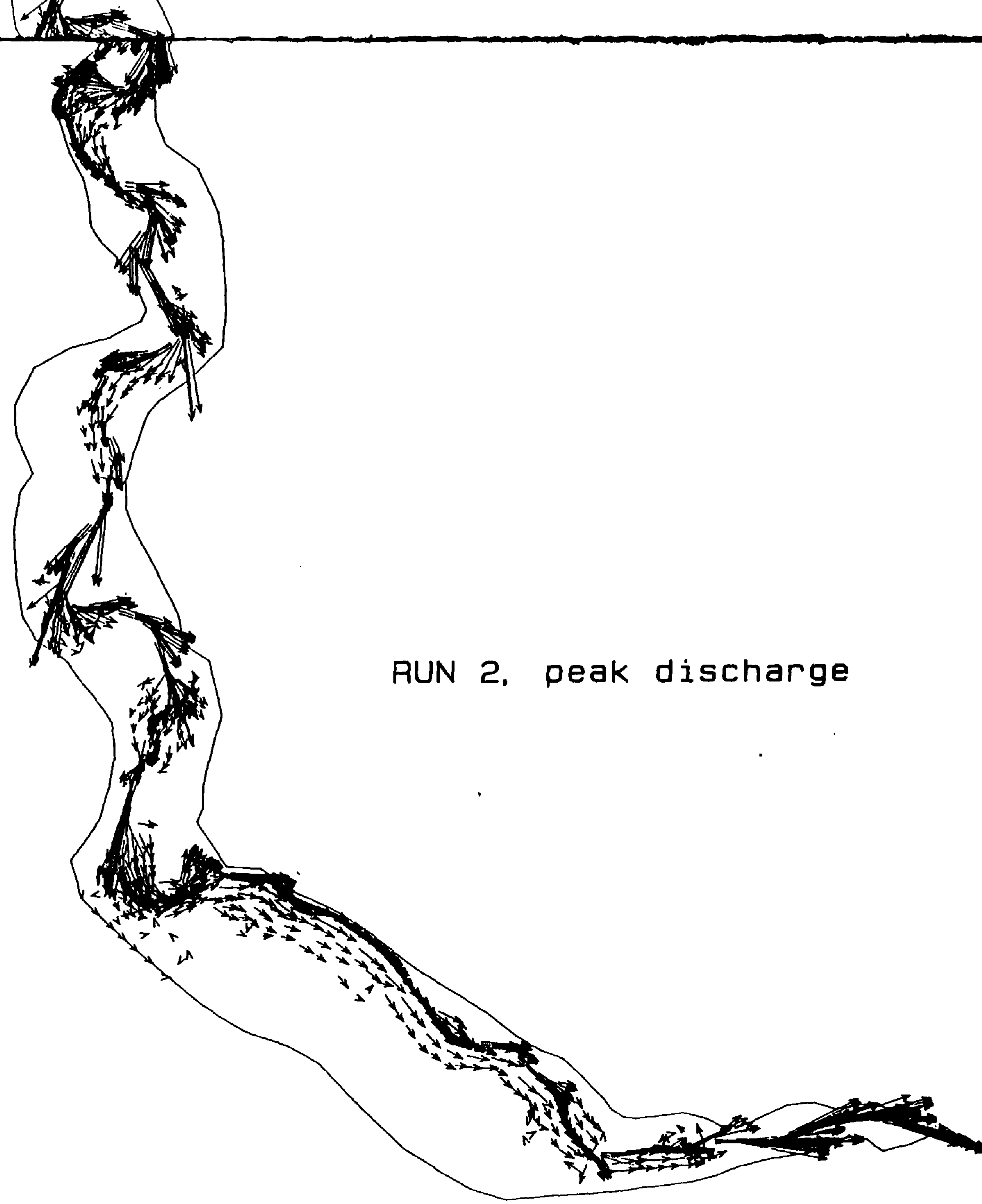
VELOCITY VECTOR PLOT

FIG 4.13a

RUN 2, bankfull

VELOCITY VECTOR PLOT

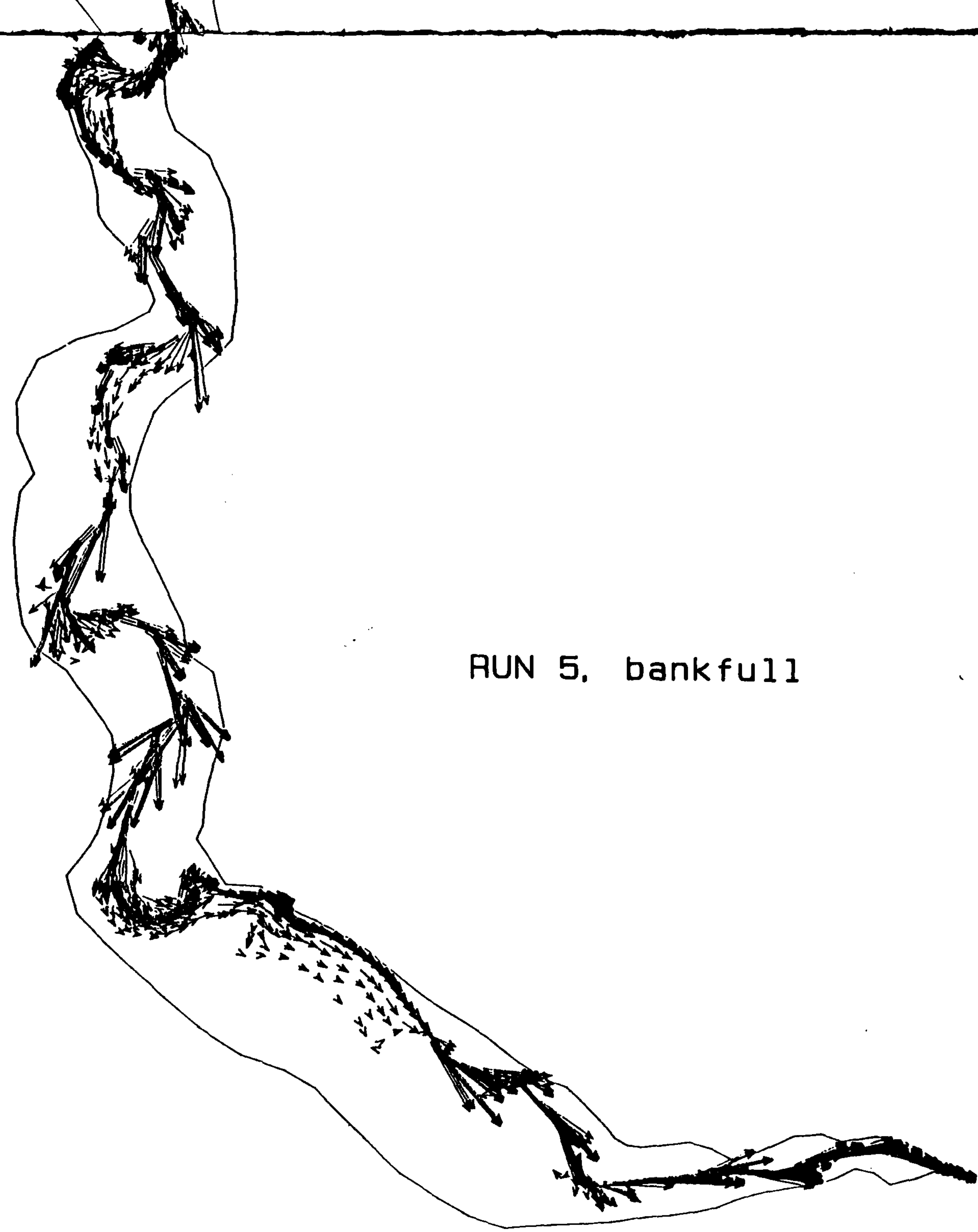
FIG 4.13b



RUN 2, peak discharge

VEOLCITY VECTOR PLOT

FIG 4.14a

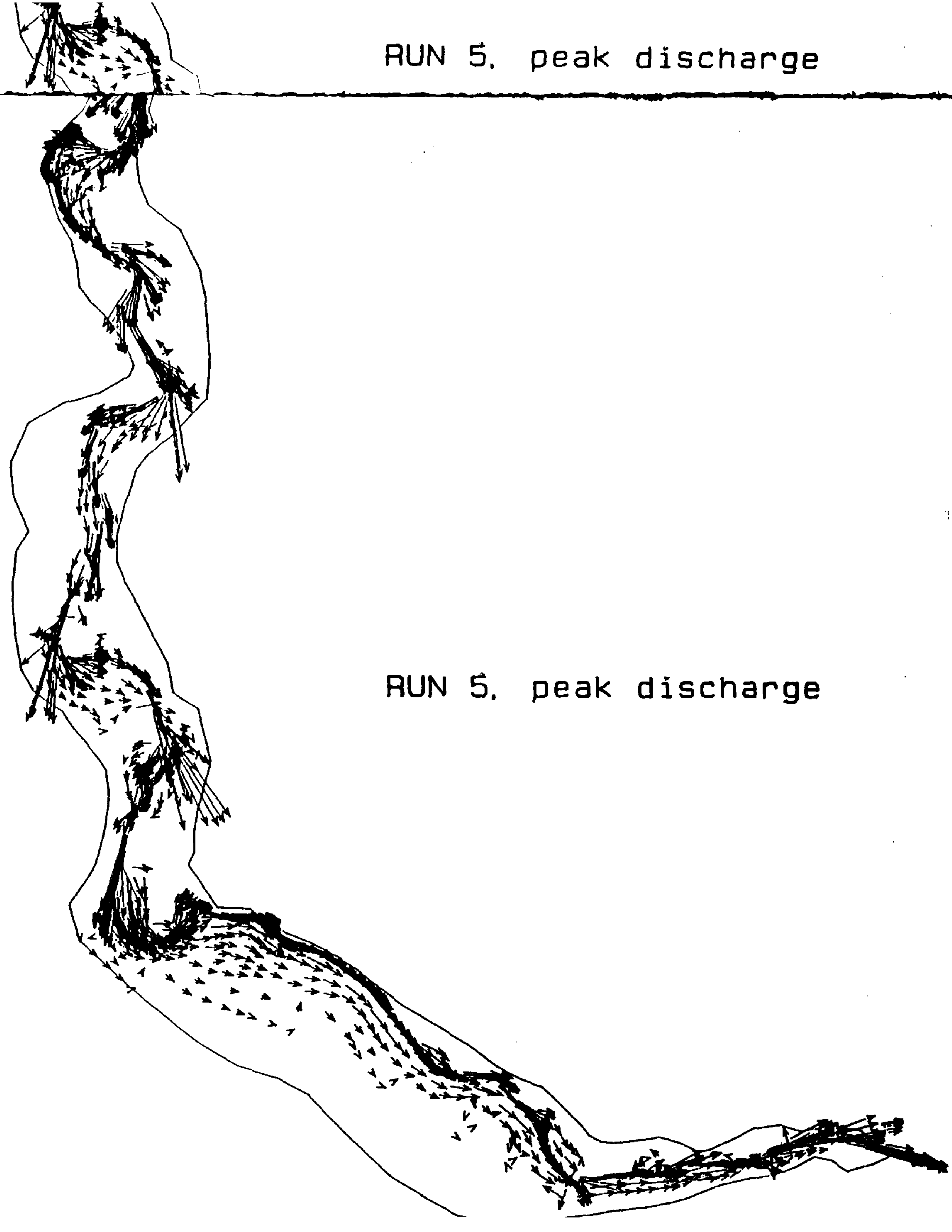


RUN 5, bankfull

VELOCITY VECTOR PLOT

FIG 4.14b

RUN 5, peak discharge



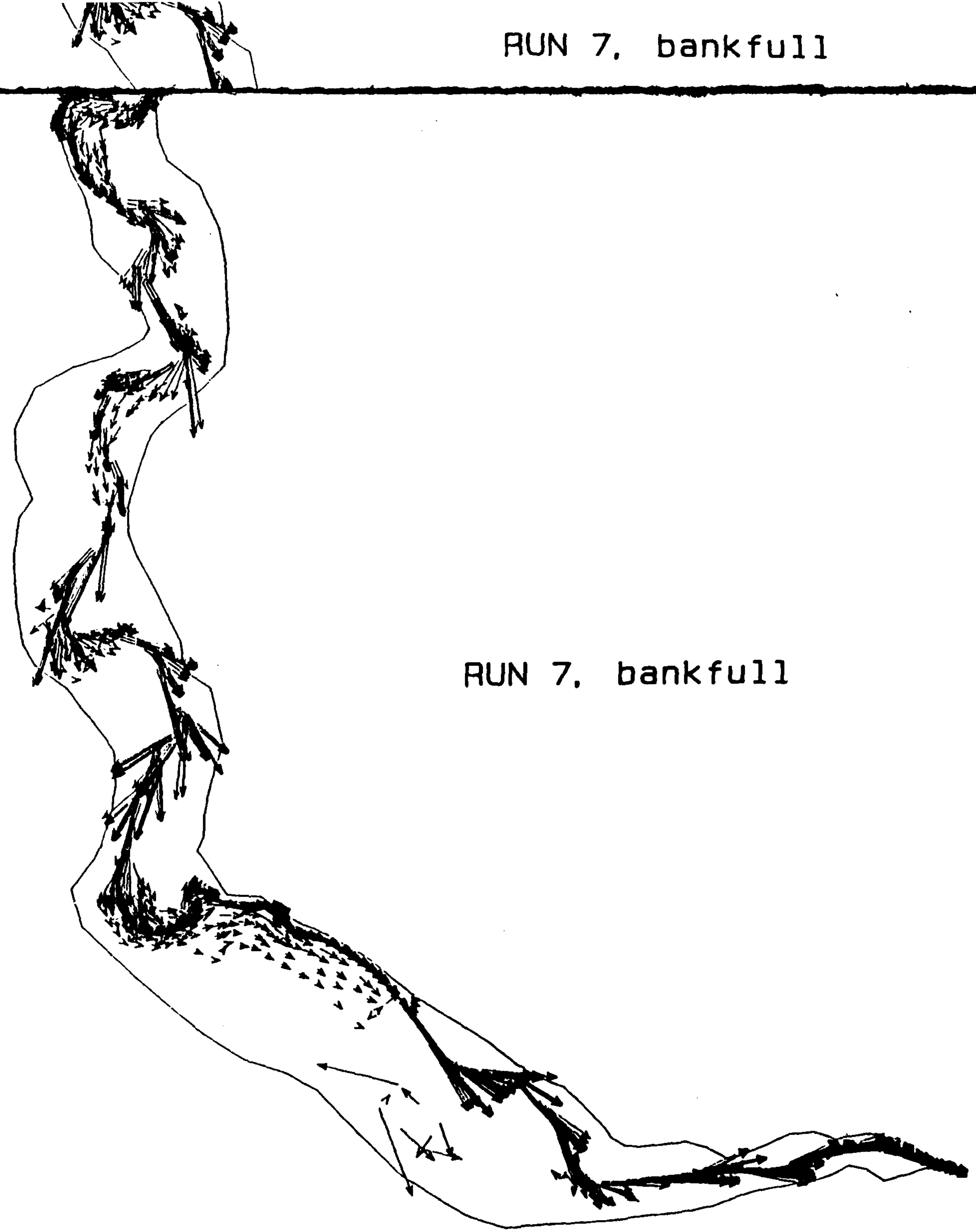
RUN 5, peak discharge

2

VELOCITY VECTOR PLOT

FIG 4.15a

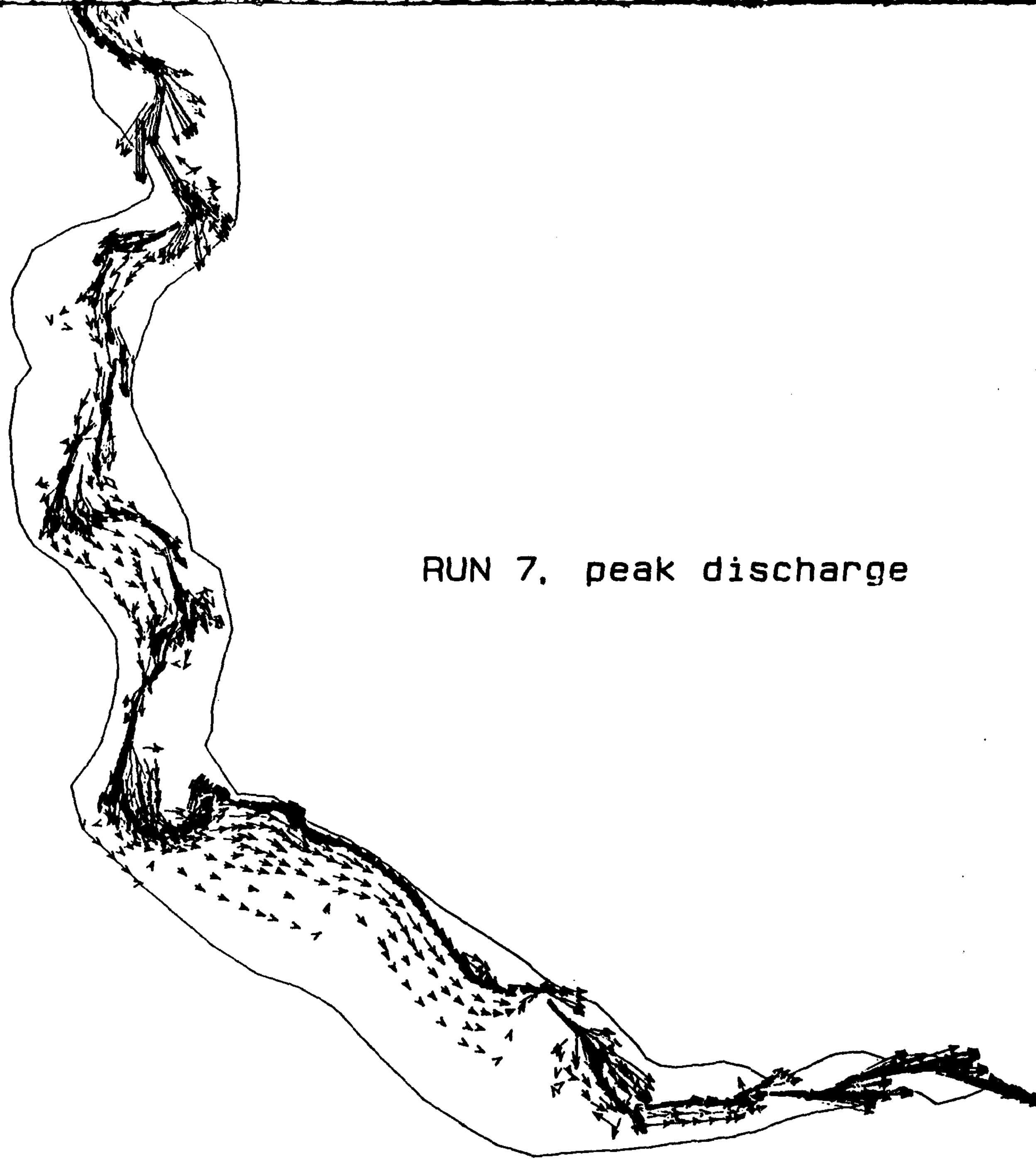
RUN 7. bankfull



VELOCITY VECTOR PLOT

FIG 4.15b

RUN 7. peak discharge



RUN 7. peak discharge

2

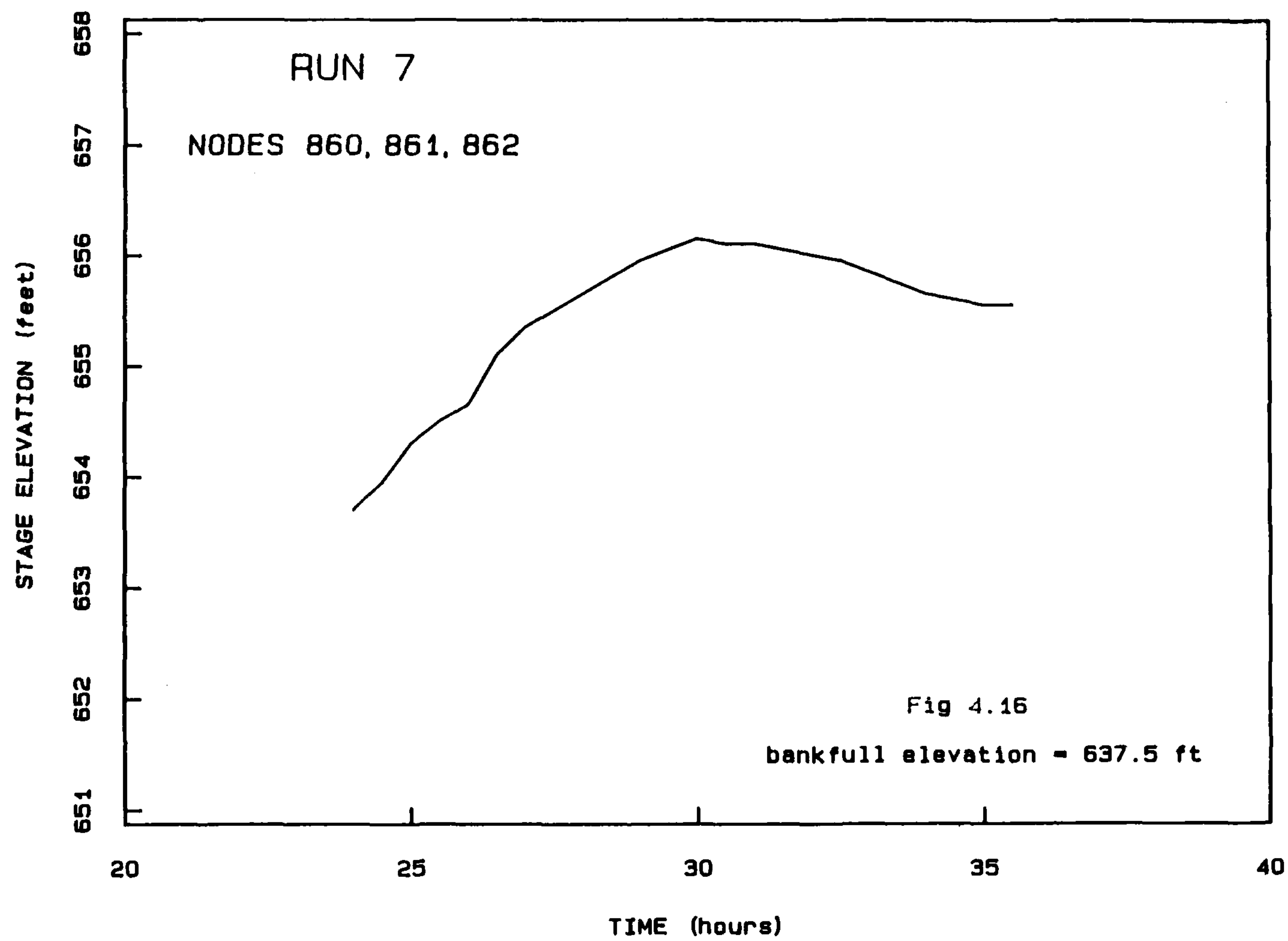


Fig 4.16

bankfull elevation = 637.5 ft

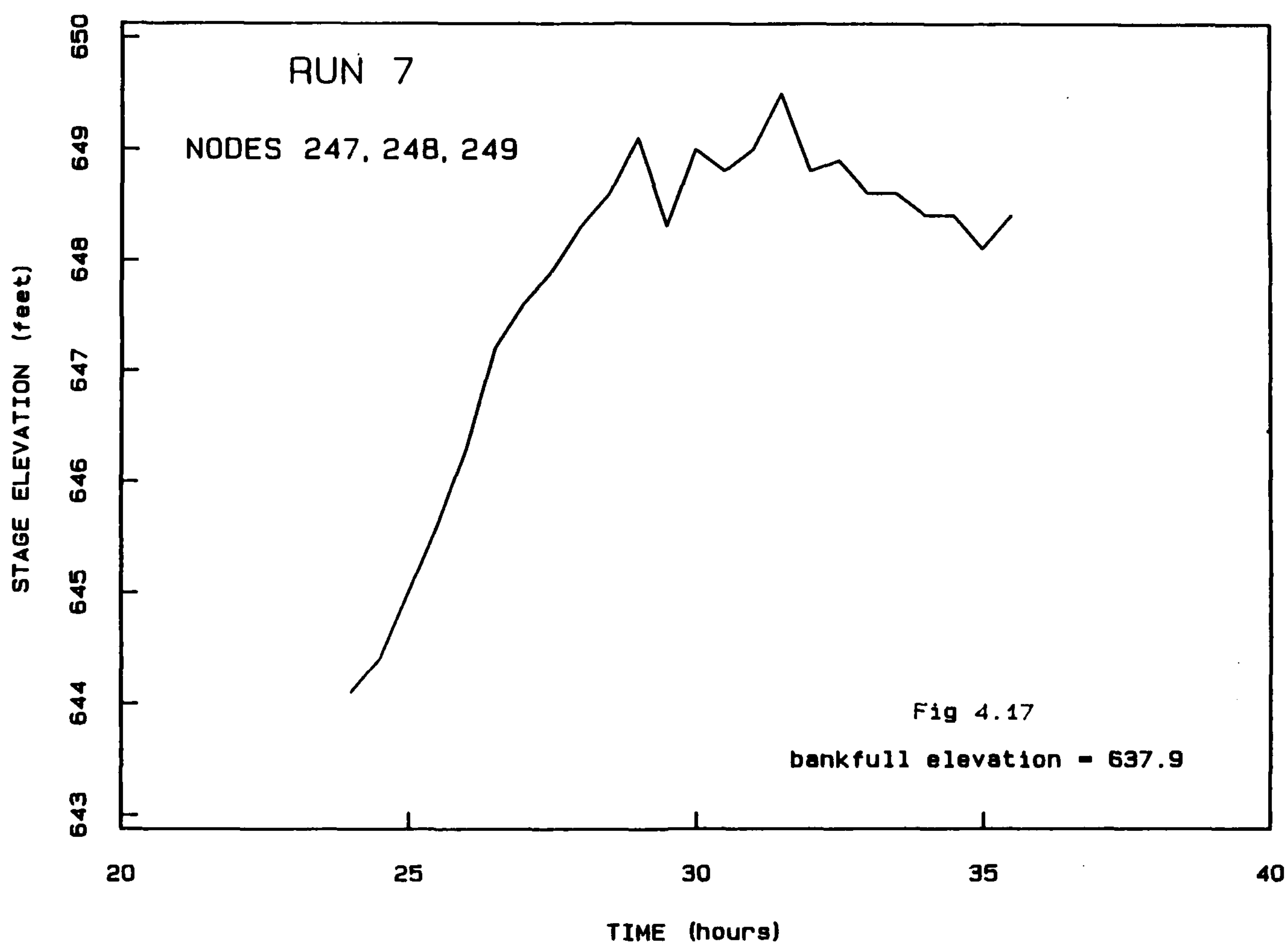


Fig 4.17

bankfull elevation = 637.9

Fig 4.18

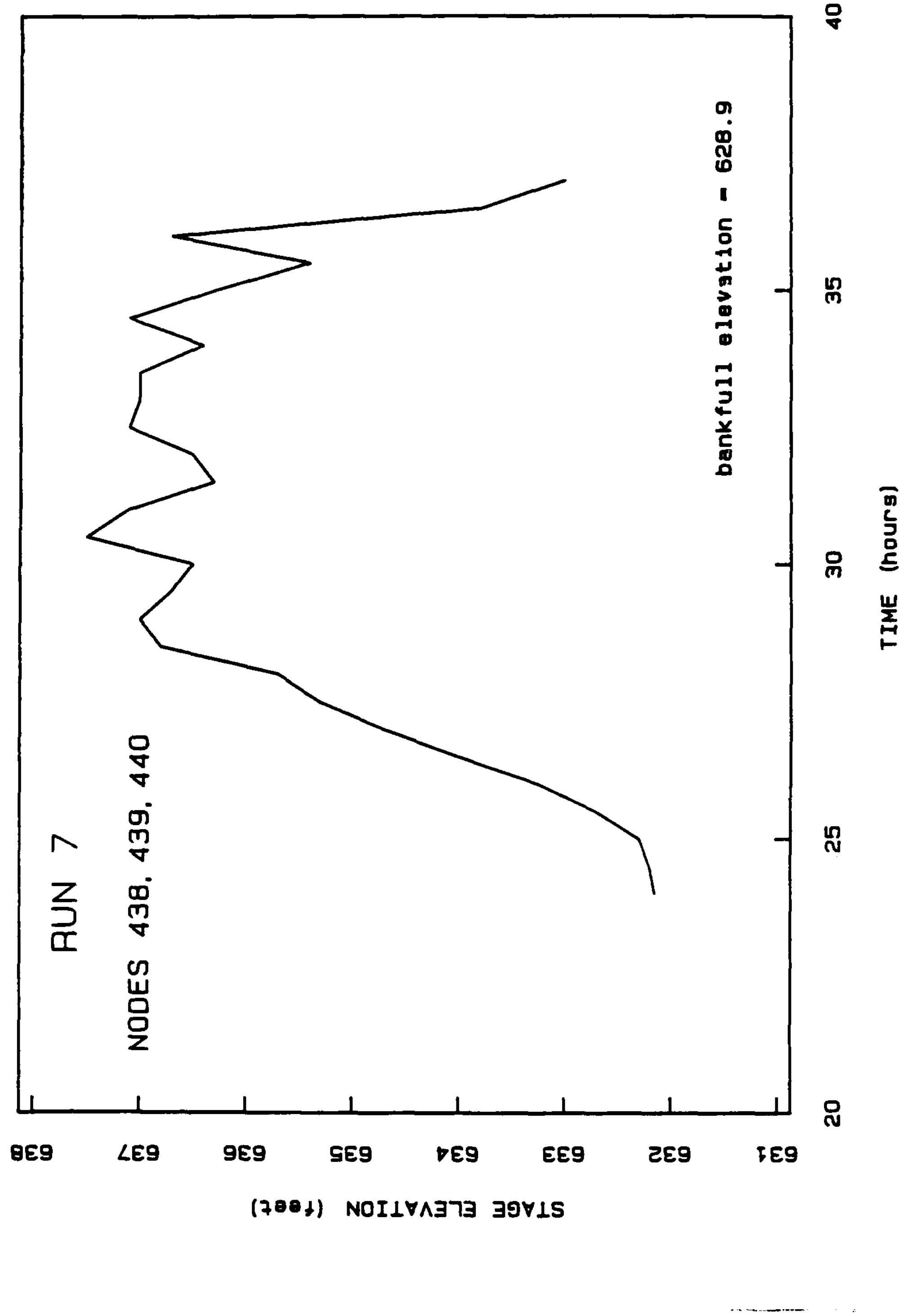

RUN 7
NODES 438, 439, 440
bankfull elevation = 628.9
TIME (hours)
STAGE ELEVATION (feet)
20
25
30
35
40
631
632
633
634
635
636
637
638

Fig 4.19

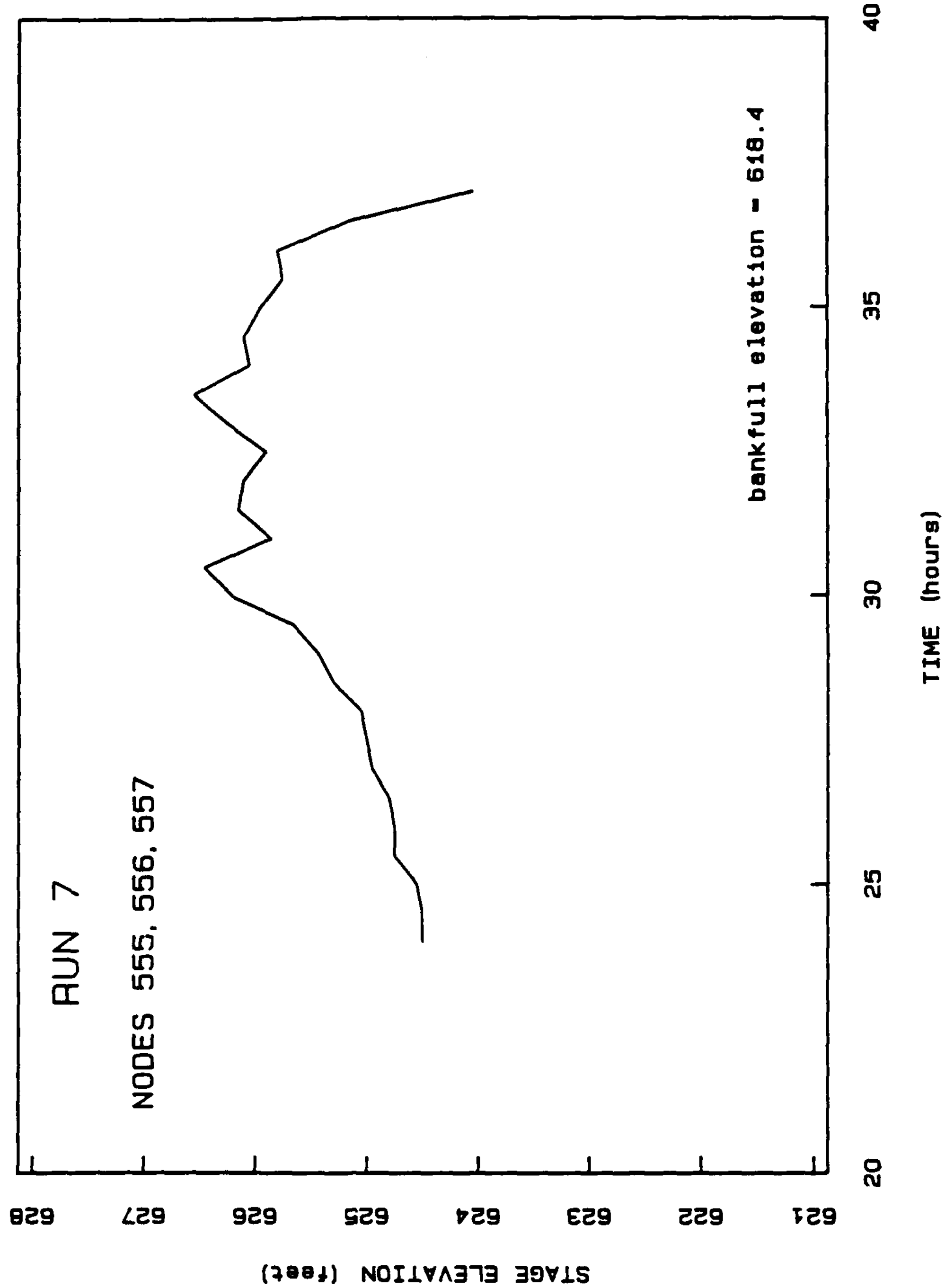
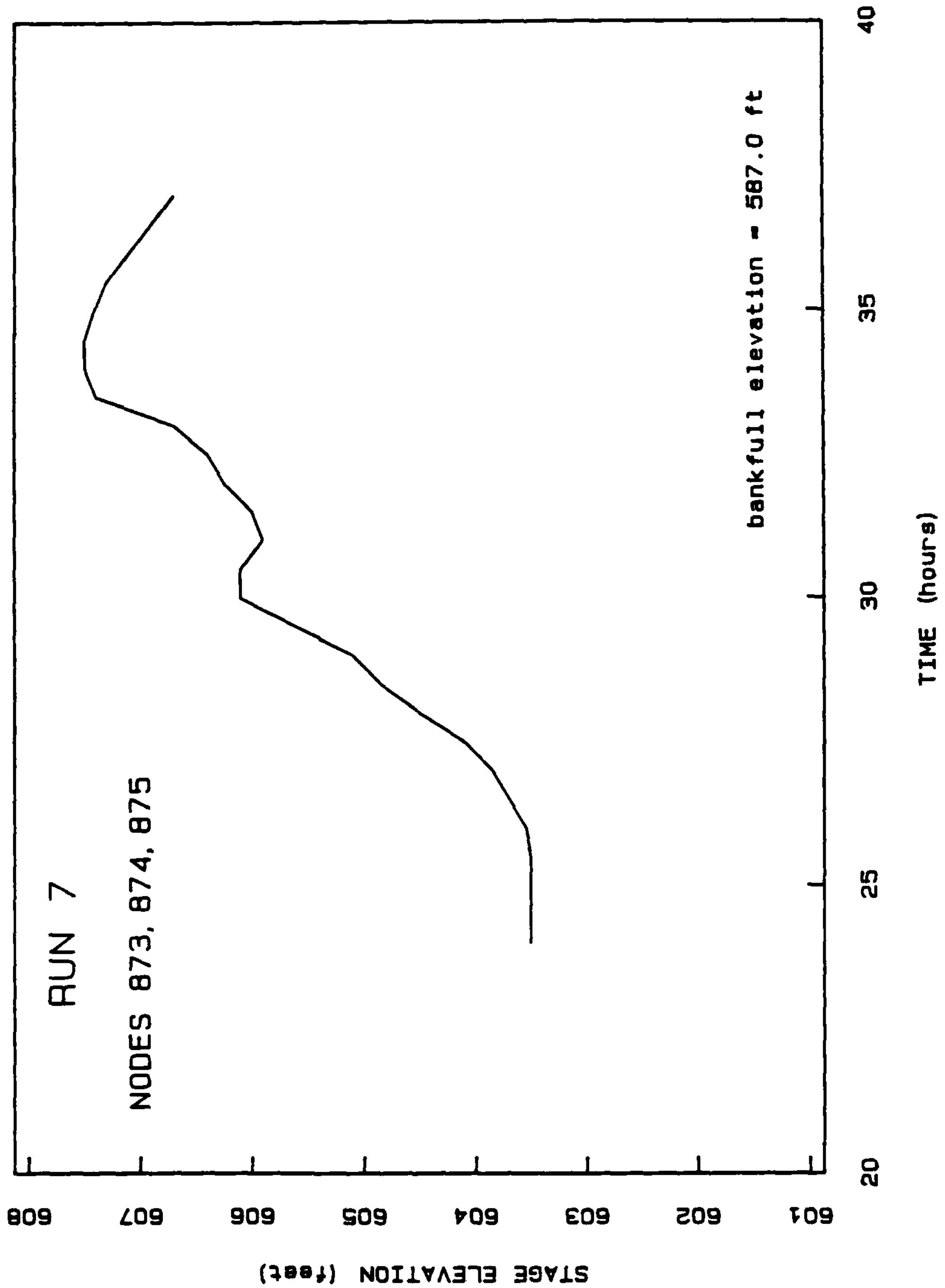

RUN 7
NODES 555, 556, 557
bankfull elevation = 618.4
TIME (hours)
20
25
30
35
40
STAGE ELEVATION (feet)
621
622
623
624
625
626
627
628

Fig 4.20


RUN 7
NODES 873, 874, 875
bankfull elevation = 587.0 ft
TIME (hours)
20
25
30
35
40
STAGE ELEVATION (feet)
601
602
603
604
605
606
607
608

V RESEARCH PLAN FOR THE NEXT SIX MONTHS

1. Application of RMA-2 to the River Haune, Marbach to Hermannspiegal. The objective of this application is check the conclusions identified in the Fulda application, under different geometric conditions. The network has already been set up and checked. Over a period of five weeks, a mesh of 2000 elements and 5000 nodes were identified.
   This is a continuation of the collaborative work with HEC.

2. Conclusion of the investigation into the roles of the hydrologic model (MILHY) and the hydraulic model (RMA-2) in the operational environment.

3. Validation of methodology and sensitivity analysis of MILHY3 on the Fulda catchment using varying scale applications from 150km^2 to 2500km^2.

4. Generation of operational rules for MILHY3

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